POWER

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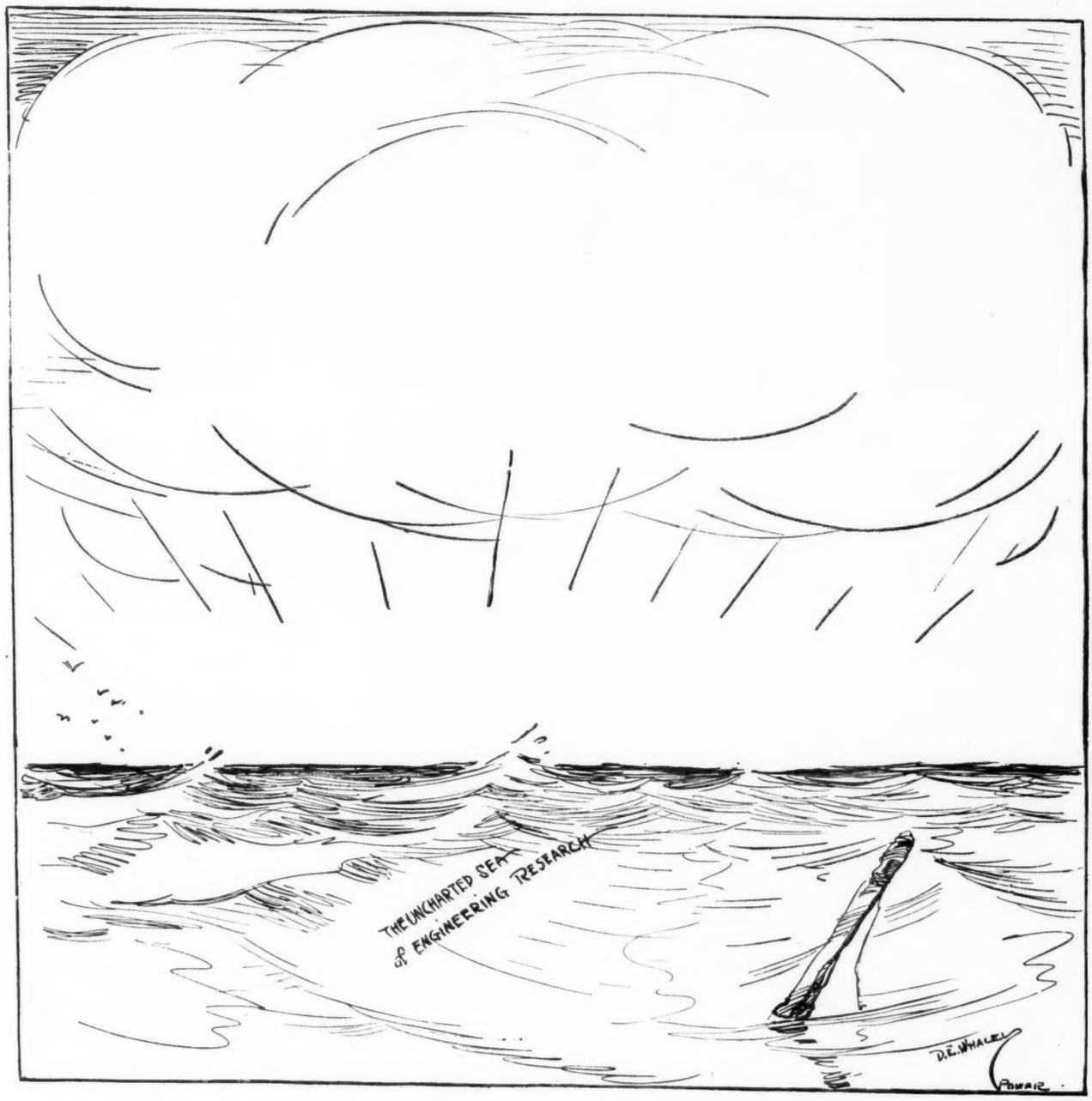
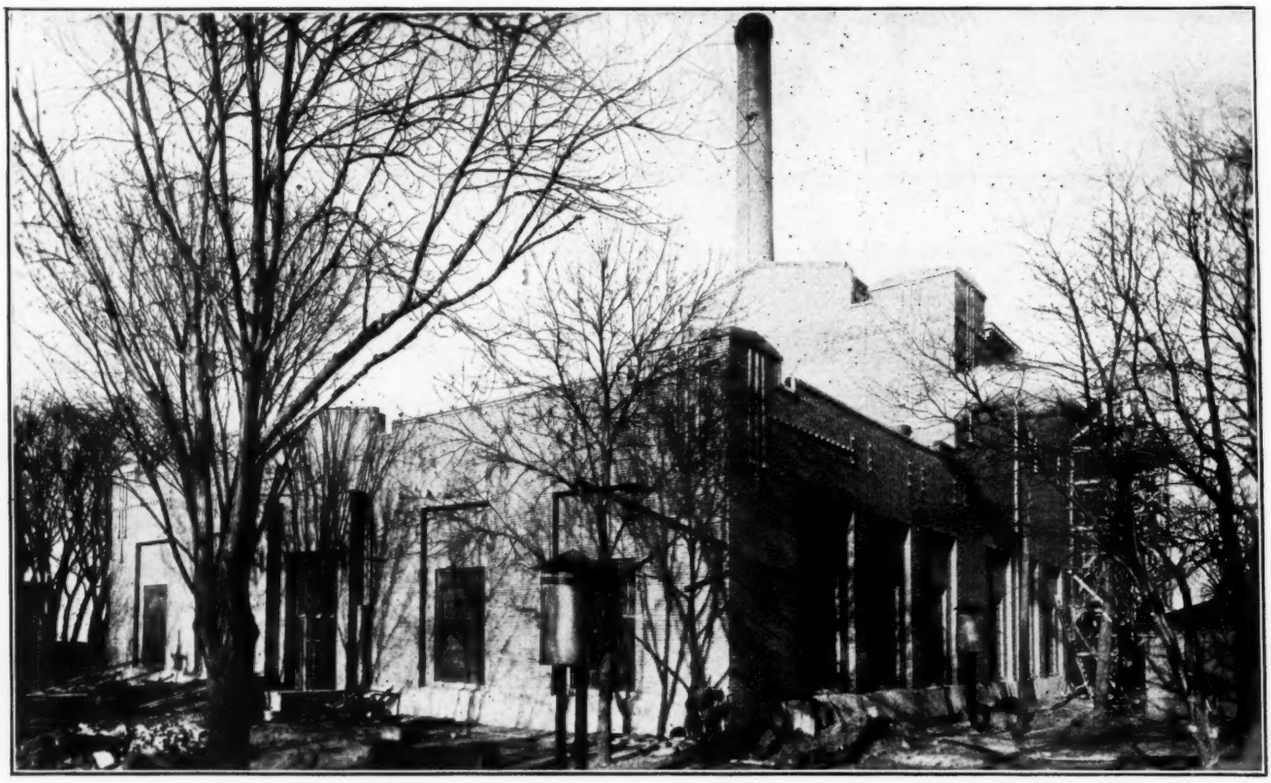


Wanted: Navigators



The New Madison Water Works

Building a new plant over an old one while maintaining the service. A choice of artesian or lake water and comparative costs. Air-lift system supplants motor-driven pumps in individual wells.

IN THE year 1914 in Madison, Wis., it was realized that the city pumping station had become inadequate to meet the growing demands entailed by the increase in population. A new or at least a remodeled station was necessary, and it was an open question whether to continue using artesian well water or to draw on Lake Mendota and insure a supply adequate to meet all future demands. The engineering problems involved and their solution are interesting, but to appreciate the new work, a brief résumé of the development of the pumping system will be needed as a background.

The original water-works system of the city was constructed in 1882, when the population was 10,384. It included slightly over 11 miles of mains costing $1.62 per foot or a trifle more than $8553.60 a mile. The building was located 2000 ft. north of the State Capitol in what is now a residential district. In 1900 it was enlarged and consisted of a one-story brick structure divided into pumproom, boiler room, and coalhouse. The first pumping engines installed were one 1,500,000-gal. and one 2,500,000-gal. unit, each consisting of a single-cylinder noncondensing Corliss engine geared to a duplex double-acting pump. In 1902 these units were supplemented by a vertical triple-expansion pumping engine of 3,000,000 gal. capacity at a cost of $21,400. Early in 1911 two horizontal duplex compound condensing pumping engines, one of 3,000,000-gal. capacity and the other rated at 1,500,000-gal., were installed, the total cost of the installation being $16,165.40. At this time much of the pumping was done by the triple-expansion pump, the smaller compound pump being in use practically every day in the year and the larger compound kept under steam for emergency use in case of sudden demand or when repairs were being made to the vertical unit.

The boiler plant consisted of three 130-hp. water-tube boilers carrying a steam pressure of 125 lb., two installed in 1898 and the third in 1909. One year later all three boilers were equipped with underfeed stokers

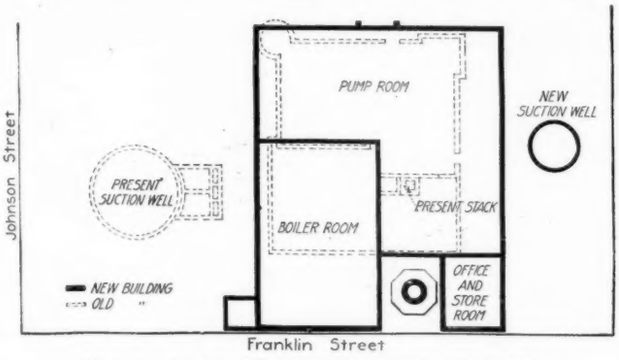


FIG. 1. PLAN OF THE PUMPING STATION

at an installation cost of $3457.51. Sufficient boiler capacity to operate the entire plant was supplied by two boilers. Water for all purposes was obtained from a system of eight artesian wells, ranging from five to ten inches in diameter, deriving their supply from the strata of Potsdam sandstone underlying southern Wisconsin. The average depth of the wells was about 800 ft. and the discharge from each of the larger ones approximated about 1,000,000 gal. per 24 hours. Four of

the wells had been located on the station grounds and, as originally they were flowing wells, had been connected for direct suction. Late in 1914 measurements showed that the water plane had been lowered to 14 ft. below the ground surface, so that an air-lift system, consisting of two motor-driven compressors and four air-lift pumps, was installed to increase the capacity of the wells. The four outside wells were operated by individual motor-driven deep-well pumps, two of the propeller type and the other two, turbine pumps. In the main station a 100-kw. direct-current generator directly connected to a Corliss engine supplied the electric energy, and provision was made to obtain power also from the central station. A 200,000-gal. brick reservoir and a 1,000,000-gal. reinforced-concrete reservoir gave storage capacity. There was direct connection to the pump suctions in the station. Distribution was by direct pressure with a 50,000-gal. elevated tank for regulating the domestic pressure.

With the station enlarged from time to time without regard to future system or appearance, it eventually contained a heterogeneous mass of machinery, little of which was suited for a permanent and economical installation. It had been purchased mostly to meet immediate necessities and had been crowded together without sufficient room for operation and repairs. The boiler room was dark and the coal storage provided was inconvenient, so that the labor of handling coal was great. Another disadvantage was the location in a residential district, imposing an expense of several thousand dollars per year for coal handling. In addition the pumping machinery had become inadequate in capacity for any considerable fire, even with every pump in use, and the water supply was not sufficient to furnish reasonable protection. Owing to the latter contingency, additional wells were necessary and more reservoir capacity to provide sufficient reserve.

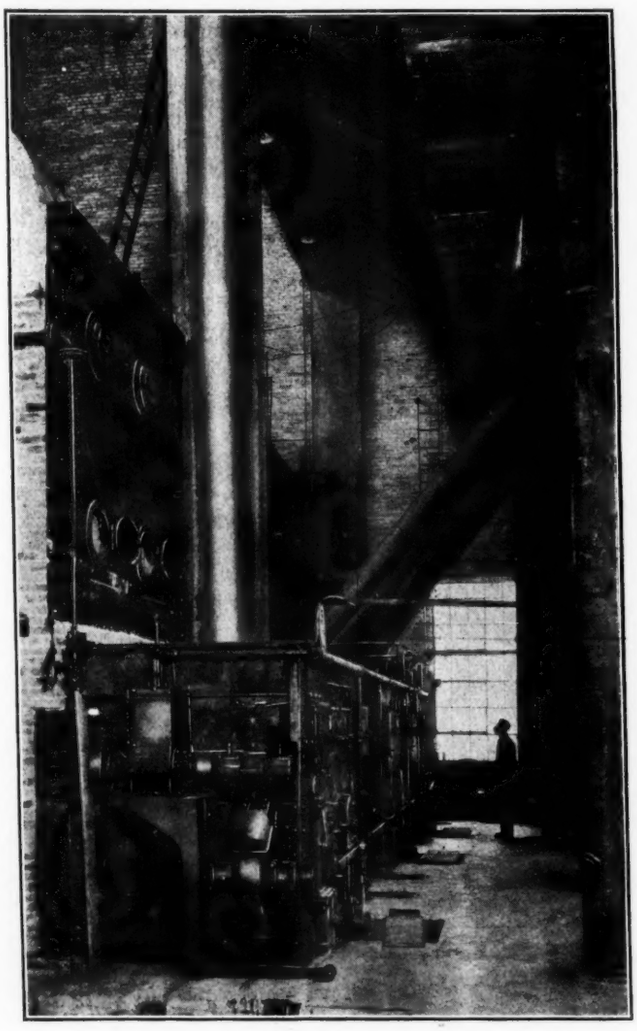


FIG. 2. THREE NEW 200-HP. STIRLING BOILERS

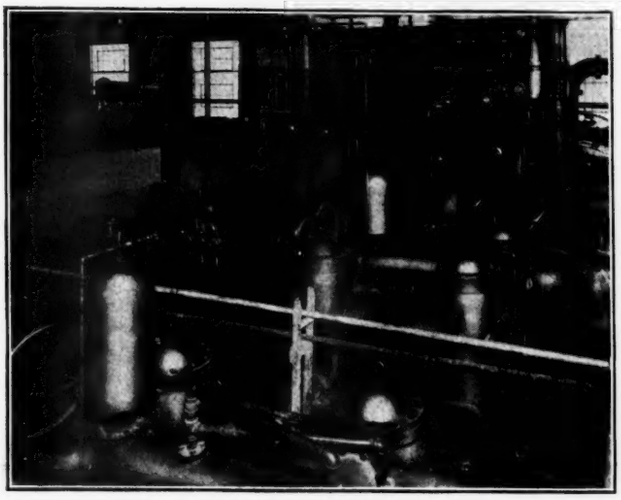


FIG. 3. OLD PUMPING EQUIPMENT RETAINED

Outside of the deficiencies already enumerated, there were objections to the water supply. The artesian water was very hard, costing the citizens of Madison thousands of dollars annually for extra soap, loss of fuel and cost of repairs to boilers and heating systems due to the formation of scale. The cost of the pumping was high because of the double pumping required, and this cost would increase as the static level of the well water fell with the increasing demand. Besides the additional operating expense in the station, a great deal of trouble and expense had been experienced in the operation and maintenance of the deep-well pumping machinery, and there would be need for a revision of plans every few years for securing additional water as the demand increased.

For these various reasons a report prepared for the city by prominent consulting engineers of Madison and Chicago favored drawing the water supply from Lake Mendota, which is within 500 ft. of the station. It has an area of 15 square miles, and disregarding rainfall or evaporation, one foot of its level would furnish Madison with eight million gallons per day for an entire year. The adoption of this source would solve the water-supply problem for Madison for all time to come. Compared with the artesian supply the lake water contained only about one-half the mineral matter in solution and would thus be more satisfactory for manufacturing, boiler and laundry uses. The great volume of lake water would give unlimited fire protection. The operating expense would be less as would the ultimate cost of development.

The only objection was the need of continuous purification by chlorination and filtration and the initial expense this equipment would entail. The size of the filters and their cost could be reduced by retaining the artesian-well system as an auxiliary fire supply to be used by pumping directly into the city mains.

In studying the problem of increased water supply

a total of sixteen different plans of possible development were considered. Electricity had been used satisfactorily for low service pumping from the wells to the reservoir and was considered for high-service pumping as well. Due consideration, however, showed its use for the latter service to be impractical on account of the great variation in the necssary rates of pumping. Although moving the plant to a new location adjacent to the railways would effect a saving in the cost of hauling coal, would remove the station from a residential district and would give better opportunities for economical design, especially for future enlargements, the first cost seemed unwarranted at that time. A full consideration of all details reduced the problem to two solutions, both using the present location of the pumping station further developed with a water supply from artesian wells in one case and a supply from Lake Mendota in the other. The city council adopted the former plan.

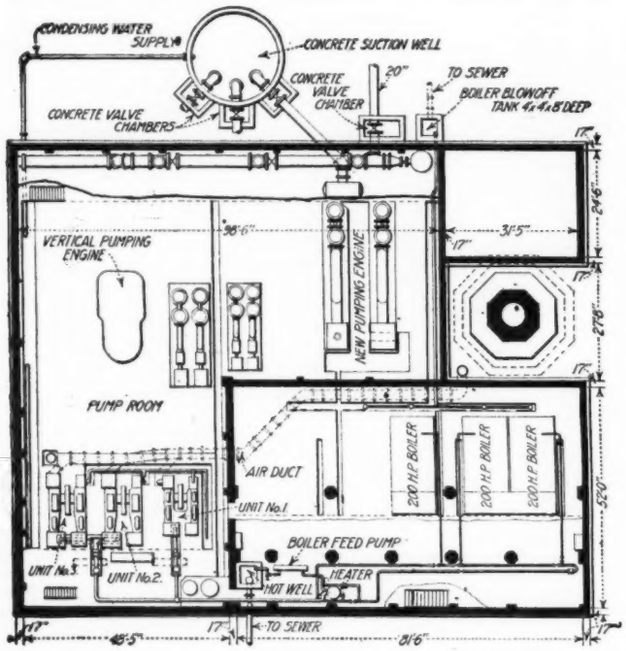


FIG. 4. SHOWING ARRANGEMENT OF EQUIPMENT

An entirely new building was constructed on the site of the old one. Three new 200-hp. water-tube boilers were installed in a modern boiler room equipped with elevated concrete coal bunkers, coal and ash-handling machinery and a new radial-block stack of ample proportions. A new eight-million gallon cross-compound crank-and-flywheel pump was installed to carry the load, and the two horizontal compound pumps and the vertical triple expansion pump were retained as reserve units. The generating set, the two motor-driven air compressors and the deep-well motor-driven pumps were removed and in their place three steam-driven compressors with air-lift pumps on all wells (four at the station and six outside) were substituted.

Thus all machinery in the station is steam-driven. For the high-service pumping directly into the main, proper speed regulation gave no choice, and with the boilers installed it was considered good practice also to operate the low service by steam, the added coal cost being about the only additional expense to be considered. A new concrete reservoir of 1,500,000 gal. capacity was built and cross-connected with the 1,000,000-gal. reservoir. Both are supplied from the low-service air-lift system and have common connection to a new suction well to which all high-service pumps are now connected.

It was decided to erect a new building over the old one, the work starting in May, 1917. The job was particularly interesting and difficult as continuous service had to be maintained, it being necessary to install the new equipment before the old could be removed. Fig. 1 shows the relative proportions in plan of the two buildings. A temporary wooden building was constructed

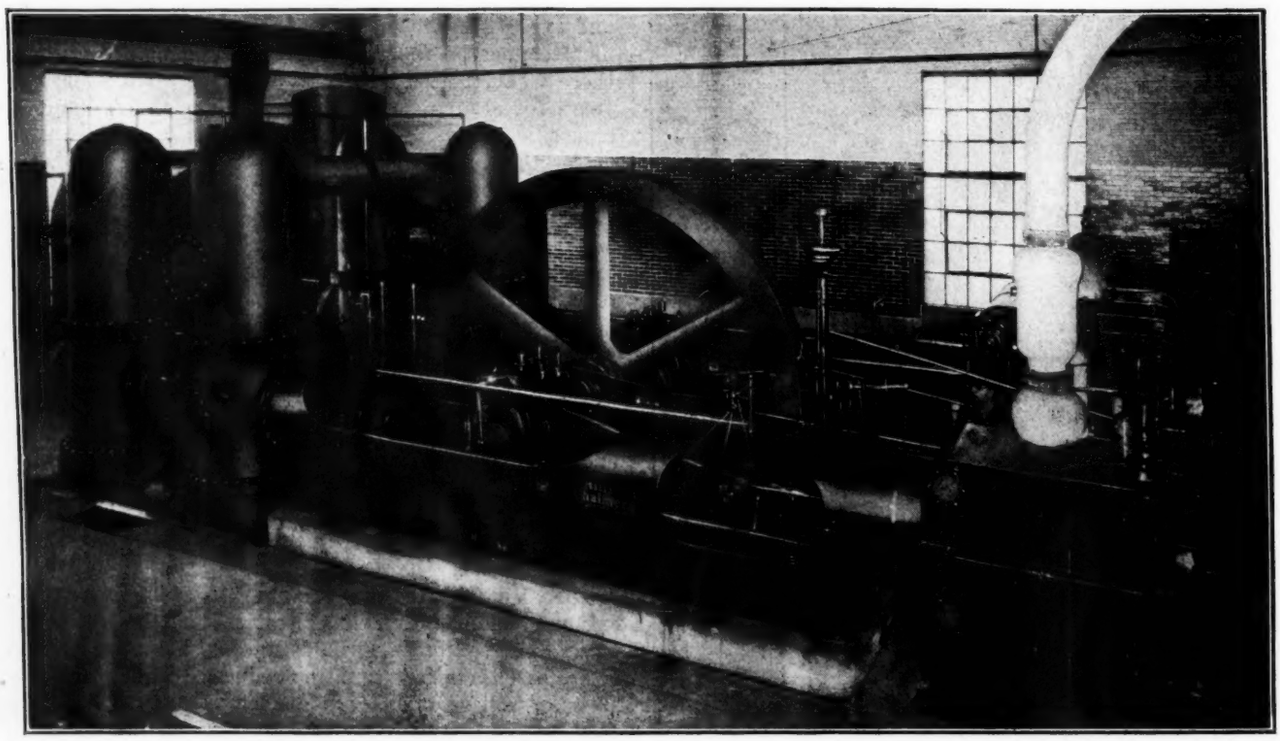


FIG. 5. THE CORLISS ENGINE-DRIVEN 8,000,000-GAL. PUMPING UNIT NEWLY INSTALLED

over the pumping machinery, and the old building was torn down with the exception of that part of it housing the old boilers. Construction of the new boiler room for the first two boilers was started, and, simultaneously, work began on the new pumping room, the foundations coming outside those for the old building. A new stack 6 ft. in diameter and 150 ft. high was erected.

When the first part of the new boiler room was completed two boilers were installed and put into service as soon as the piping connections could be made for carrying the station load. The old boilers were then dismantled, the old chimney torn down and the balance of the boiler room completed. Another boiler was installed, with space for two more, and the coal- and ash-handling equipment put in place.

With the roof over the new pumping room the temporary wooden inclosure was torn out and the new eight-million gallon unit put into commission. This gave an opportunity to remove the old 2,500,000-gal. duplex geared pump, the motor-driven air compressors and the generating set to make room for the three steam-driven air compressors serving the new air-lift system. The two compounds and the vertical triple-expansion pumps remained on their old foundations. The high-pressure steam piping was transferred to the new header, the suctions were changed from the old to the new suction well and the discharge of all pumps connected into a common 30-in. header in the pipe gallery. The normal water pressure is 85 lb. and the maximum fire pressure 125 lb. The speed of the new pump is controlled by a water-pressure governor and that of the older pumps by means of the steam throttle. Each of the pumps is equipped with the usual water-works type of condenser with steam-driven auxiliaries. The general layout of the station is given in Fig. 4, and Figs. 3 and 5 show the pumping equipment.

Fig. 2 is a view of the new boilers, the installation of the third boiler having just been completed. Each unit is of the Stirling type and rated at 200 horsepower. The operating pressure is 150 lb., with no superheat.

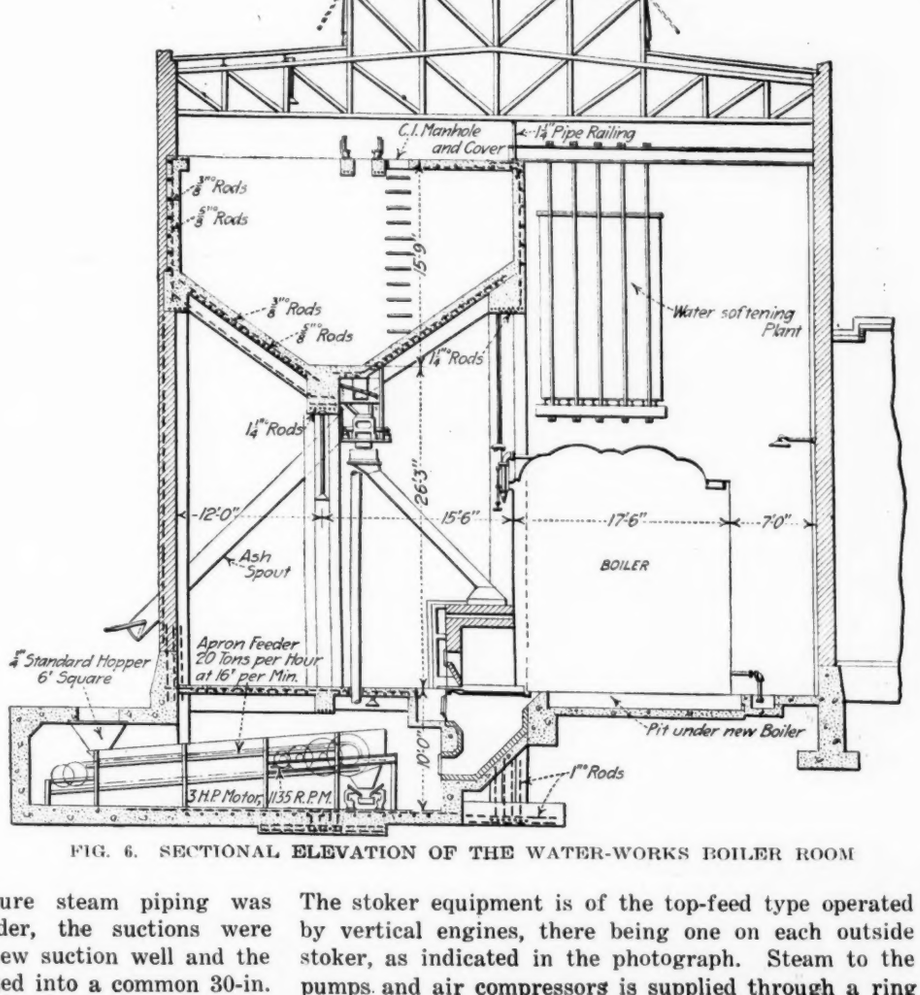


FIG. 6. SECTIONAL ELEVATION OF THE WATER-WORKS BOILER ROOM

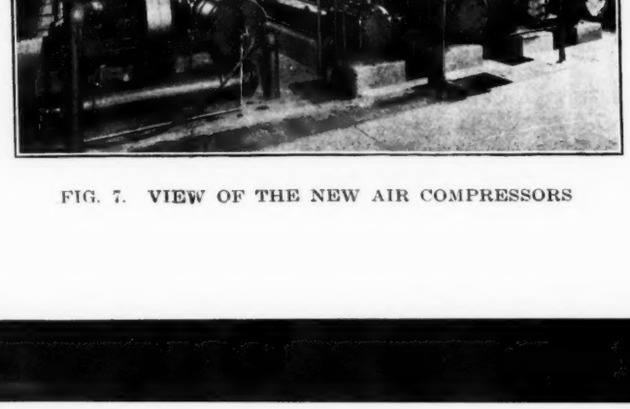


FIG. 7. VIEW OF THE NEW AIR COMPRESSORS

The stoker equipment is of the top-feed type operated by vertical engines, there being one on each outside stoker, as indicated in the photograph. Steam to the pumps and air compressors is supplied through a ring header making the circuit of the pumping room. It is supported by wall brackets with walking-board attachments. In the boiler-feed piping the ring system is also employed.

Fig. 6, a sectional view of the boiler room, shows the arrangements for coal and ash handling. The coal is delivered in trucks and dumped into a hopper under the driveway. By an apron conveyor it is transferred to a continuous bucket carrier delivering to individual overhead reinforced-concrete bunkers having an aggregate capacity of 500 tons. Each conveyor is motor-driven, and the rated capacity of the system is 20 tons per hour. The continuous bucket conveyor has the now standard feature by which a bucket out of line shuts off the power and stops the carrier. From the bunker the coal is passed through an automatic coal scale into the bifurcated spout feeding the stoker. Each scale is provided with a motor-driven screw used to feed the coal into the scale hopper when it is wet and will not flow readily. Another provision not always made is a spout from each bunker to the lower run of the conveyor in the basement. If the coal starts to heat in the bunker, it can be dis-

charged into the conveyor and given a chance to cool on its way back to the bunker.

Ashes are shoveled directly from the hopper under the stoker into the bucket conveyor, the distance from the hopper door to the conveyor being about six feet, and are elevated to an overhead bunker provided with a spout leading out to the driveway.

Feed water for the boilers is principally condensation, all of which is collected in a hotwell located above direct-

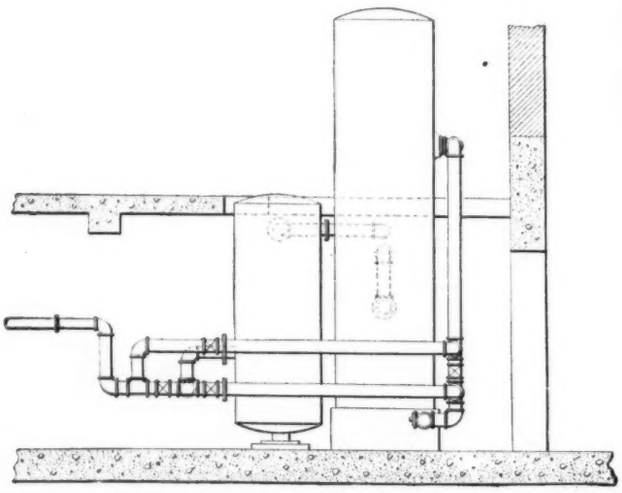


FIG. 8. CONNECTIONS OF THE COMPRESSED-AIR TANKS

acting boiler-feed pumps. By these pumps the water is forced through either unit of a twin grease extractor and a vertical closed heater to the boilers. The pumps are equipped with pressure governors, and each boiler has its individual feed-water regulator.

To remove the scale-forming matter in the artesian water used for makeup, a softener employing soda ash and having a capacity of 2000 gal. per hour, has been provided. It is suspended from beams spanning from the outside wall to the top of the bunkers. Water from the storage compartment of the softener goes to the hotwell under float control.

One of the interesting features of the plant is the new air-lift system serving the ten artesian wells supplying the city with water. For the low-pressure pumping, primary steam units were desired as they would add little more than the cost of coal to the steam requirements of the high-pressure service. In addition the air-lift pump is simple, requiring little attention, and with a booster tank that will discharge the water against a combined head of 80 ft., by means of accumulated air, into the reservoir, was quite feasible in the present case. The most remote well is about 4000 ft. distant from the plant.

In the station the steam-using equipment consists of three cross-compound air compressors, one having a capacity of 940 cu.ft. per minute and each of the remaining two 1500 cu.ft. per minute. The steam ends are equipped with surface condensers, having steam-driven auxiliaries. The condenser serving the smaller compressor has 400 sq.ft. of cooling surface. A second condenser serving either of the two larger compressors has 500 sq.ft. of surface. Normally, only one of the larger compressors is operated at a time to supply air for the six outside wells, while the smaller compressor serves the four station wells. These machines are shown in Fig. 7, and Fig. 8 shows how the receivers are cross-connected so that if desirable any machine may be used on either

COST OF IMPROVEMENTS IN MADISON WATER WORKS

Concrete storage reservoir	$19,752.58
Suction well	2,367.43
Repair to old storage reservoir	2,452.66
Equalizer main	22,038.81
Stack—6x150 ft., including foundation	5,349.33
Station building	96,713.89
Boiler and stoker equipment	26,228.01
Air and discharge lines	14,395.82
Air compressors and air-lift equipment	34,473.80
Pumping engine and discharge pipes	38,897.04
Discharge header	10,449.74
Miscellaneous equipment and construction expense	6,892.51
Steam and station water pipe and covering	17,472.55
Steam heating	1,364.48
Coal- and ash-handling machinery	12,711.12
Water softener	3,060.34
Sidewalks and improvements to grounds	2,000.00
Total cost, exclusive of engineering	$316,620.11

service or on both. The station wells discharge into the old suction well, which has connection with the 1,000,000 gal. reservoir, and the outside wells, with one exception, will eventually discharge into the new reservoir. As previously stated, both reservoirs are cross-connected and have a common main to the new suction well now supplying all high-pressure pumps.

From the large receiver a 6-in. pipe leads out of the station to the outside wells. As it progresses, it is reduced to 5 in. and then to 4½ in. The line is laid in the ground and is protected from corrosion by machine-wrapped canvas painted with asphaltum. To each well there is a 2-in. branch connection, and the discharge pipes from wells of 8, 10 and 12 in. diameters are 5, 6 and 7 in. respectively. The pressure out of the station

PRINCIPAL EQUIPMENT OF MADISON WATER WORKS, MADISON, WIS.

No.	Equipment	Kind	Size	Use	Operating Conditions	Type
3	Boilers	Water-tube	200-hp.	Generate steam	150 lb. press., natural drafts, stokers	Stirling
3	Stokers	Top feed	40-sq.ft.	Serve boilers		Murphy
1	Stack	Radial brick	6x150-ft.	Serve boilers		Heine
3	Scales	Automatic		Weigh coal to boilers	Special screw feeder for wet coal	Richardson
1	Conveyor	Apron	20 tons per hr. at 16 ft. per min.	Coal from hopper to cont. conv.	Driven by 3-hp. G.E. ind. motor	Link-Belt
1	Conveyor	Cont. bucket	20 tons per hr. at 40 ft. per min.	Elevate coal to bunkers	Driven by 5-hp. G.E. ind. motor	Link-Belt
1	Heater	Closed, vertical	111 sq.ft.	Heat feed water	Exhaust steam	Whitlock
1	Softener	Cold process, soda ash	2,000-gal. per hr.	Soften makeup		Graver
1	Pump	Simplex outside center packed	8 x 5 x 12 in.	Feed-water		American
2	Pumps	Duplex	6 x 4 x 6 in.	Feedwater	Old	Prescott
1	Pumping engine	Crank and flywheel	8,000,000-gal.	High-pressure service	150-lb. steam, normal water press; 85 lb.	Allis-Chalmers
1	Condenser	Surface	650-sq.ft.	Serve 8,000,000-gal. pump	Steam-driven auxiliaries	Allis-Chalmers
1	Pumping engine	Triple-expansion vertical	3,000,000-gal.	High-pressure service	150-lb. steam, 85 lb. water	Allis-Chalmers
1	Condenser	Surface	311-sq.ft.	Serve 3,000,000-gal. pump	Steam-driven auxiliaries	Allis-Chalmers
1	Pump	Horizontal-duplex	3,000,000-gal.	High-pressure service	150 lb. steam, 85 lb. water	Prescott
1	Condenser	Surface			Steam-driven auxiliaries	Prescott
1	Pump	Horizontal-duplex	1,500,000-gal.	High-pressure service	150-lb. steam, 85-lb. water	Prescott
1	Condenser	Surface			Steam-driven auxiliaries	Prescott
2	Air compressors	Cross-compound	1,500-cu.ft. per min.	Serve air lift	Steam 150 lb., air 110 lb.	Ingersoll-Rand
1	Condenser	Surface	500-sq.ft.	Serves either 1500-cu.ft. comp.	Steam-driven auxiliarie	Wheeler C.&E. Co.
1	Air compressor	Cross-compound	940-cu.ft. per min.	Serves air lift	Steam 150 lb., air 110 lb.	Ingersoll-Rand
1	Condenser	Surface	400-sq.ft.	Serves 940 cu.ft. comp	Steam-driven auxiliari s	Wheeler C.&E. Co.
1	Air-lift system		10 wells	Water from wells to reservoirs	Station wells lift 14 ft., outside wells, 800 ft.	Indiana

is 110 lb. gage, and the drop in the line is not more than 4 or 5 lb. The output from wells of the diameters given are 500,000, 900,000 and 1,375,000 gal. each per 24 hours, giving a total of over 5,000,000 gal. from the six outside wells. To lift the water to the surface from the wells and deliver it by means of the separator pumps to the reservoir requires 56.5 i.hp. per gal. per min. At the present writing no tests have been made that would determine accurately the cost per indicated horsepower.

The entire work of remodeling the water-works system was under the direction of Daniel W. Mead and Charles V. Seastone, consulting engineers, of Madison, Wis. R. G. Walter, of this firm, had direct supervision of the construction.

Selection of Proper Starting Switches for Induction Motors

BY H. SOUTHWOOD

When selecting starting switches for induction motors, due consideration should be given to the service voltage, the normal ampere capacity, the desired protection, the starting characteristics of motor, the nature of the load, the average number of operations daily, direct operation or shipper-rod operation, inching and the inspection of the equipment.

Small motors up to 5 or 7.5-hp. capacity, operating on 550 volts or less, may be thrown directly across the line without causing a serious drop in voltage. For motors above 7.5 hp., central stations usually require their customers to furnish some means of starting at reduced voltage so that the starting current will not cause the line voltage to fluctuate excessively.

Three-phase motors are sometimes started and brought up to speed with a star connection of the windings and then connected in delta for running. However, the most common method of starting induction motors is by the use of an auto-transformer or compensator, which provides taps for starting at reduced voltage. The auto-transformers are usually disconnected from the line and from the motor when the starter is in the running position, with the motor connected directly to the line.

The current-carrying capacity of the starter should be large enough to take care of the starting current and the overload-rating guarantee of the motor (usually 25 per cent. for two hours). For instance, the starting switch for a squirrel-cage induction motor whose name-plate amperes is 10, should be able to carry approximately 60 amperes for the period of starting (2 to 6 seconds), 12.5 amperes for 2 hours and normal amperes indefinitely without excessive rise in temperature of the current-carrying parts.

In the case of induction motors protection for the running conditions will not in general stand the strain of starting conditions, the conditions are so radically different that protection for starting conditions affords little or no protection for running conditions. Hence, in many cases the starter provides for a starting position at either reduced or full voltage, with no other protection than the fuses in the branch and main circuits, and a running position that provides additional protection to suit the running conditions of the motor.

If the motor is protected by fuses in the running circuit only, it is common practice to select a fuse whose continuous current-carrying capacity will allow for the overload guarantee of the motor and will blow when the current exceeds this amount. The table shows the results obtained from a test made on fuses of five different manufacturers to determine the time required for them to open the circuit when carrying 200 per cent. normal current. From the table it is seen that the time varies from 3 to 29.5 sec. However, any motor will carry 200 per cent. full load without injury for a much longer period than given in the table.

NATURAL TIME LAG OF 10-AMPERE FUSES

Fuse Rating, Amperes	Per Cent. of Rated Current	Time Lag in Seconds
10	200	17.5
10	200	29.5
10	200	8.3
10	200	3.0
10	200	5.5

If the motor is protected by series overload relays, it is common practice to set the overload devices to operate when the current exceeds approximately 130 per cent. of the name-plate amperes of the motor. A time-limit attachment or some other retarding device should be used to prevent the starter from tripping momentary overloads or during the starting period. Means should also be provided for preventing the restarting of the motor upon the reëstablishment of normal voltage after total or partial loss of voltage, until the starter has been brought to the "off" position. This protection is usually furnished by a so-called undervoltage trip attachment.

Induction motors of different manufacture have practically identical starting characteristics as far as switching equipment is concerned. The starting current of different induction motors varies from 450 to 600 per cent of the full-load current and is practically independent of the load.

The starting current decreases to normal running current almost instantaneously when the motor starts with no load, and in 4 to 8 sec. when it starts with full load. Loads that require more time for the motor to reach normal running speed are considered as special applications and may require special retarding devices on the starting switch.

The useful life of a properly selected starter depends mainly on the number of operations daily and on the thoroughness of inspection. The average starter is good for five to ten years of service in the usual application before mechanical deterioration causes the switch to fail. With frequent inspection of the current-carrying parts and renewal of the contact members when necessary, failure due to electrical deterioration is very remote. Mechanical and electrical deterioration is generally more excessive with shipper rod operation than with direct manual control. For motors whose connected load requires "inching," starters with a quick-make and quick-break contact mechanism will give longer service per set of contact members than other types. The quick make-and-break mechanism tends to prevent teasing of the contacts and excessive burning and pitting of their surfaces, which frequently causes abnormal heating. Periodical inspection of starting switches is of great importance. Many expensive shutdowns are prevented by renewing contact members and other worn parts before they fail.

Sir Robert Borden, the Premier of Canada, in a statement dealing with the natural resources of the Dominion, emphasizes the great force of potential energy in the form of water power. On the River St. Lawrence alone, between Lake Ontario and Montreal, he estimates that 2,500,000 hp. can be developed.

Lubrication in the Power Plant

By J. D. ROBERTS

General requirements and points to be considered in the selection of an oil. The meaning of viscosity and how determined. A number of simple tests that may be made by the plant operator.

EXTREME care is necessary in selecting lubricating oils for a specific purpose. Careful study and investigation into the friction and the characteristics of the various machine bearings and such parts as are to be lubricated is essential before selecting the oil for that particular work. As a general rule there are two kinds of friction in machines to be lubricated—solid friction resulting from actual contact of a moving surface, and fluid friction due to the resistance the lubricant offers to motion. Since solid friction is much greater than fluid friction, lubricants are used to separate the moving parts of machines and so substitute fluid friction for solid friction. With smooth bearings at high speeds and under moderate pressures, this substitution is practically complete with a suitable oil, and the friction developed is proportional to the true viscosity of the oil. It is needless to state that solid friction produces a greater loss of power and greater heating of the bearings with a consequent lowering of the viscosity of the oil by heating and wear.

Conditions Determining Selection of Oils

In perfect lubrication the moving part is entirely supported or floated on a film of oil that should be of sufficient thickness to keep the journal and bearings apart under all reasonable conditions. To maintain such a film, the oil must have sufficient viscosity or body. Pressure, speed, working temperature, condition of the bearings and the method of oil feed determine the most advantageous oil to use. As a rule high pressures on bearing surfaces require oils of higher viscosity than do low pressures. Naturally, this should be expected because of the greater weight per square inch of bearing squeezing the oil from between the friction surfaces. It is also a general rule that with the same bearing pressures a fast-moving journal can be lubricated satisfactorily with a thinner or less viscous oil than can a slower journal. This is apparently due to the fact that the speedier journal sucks in more oil between the moving parts, thus aiding in maintaining the film. For bearings that operate at high temperatures, such as in the electric motor, an oil of greater viscosity is required than for bearings of lower working temperature under similar speeds and pressures. High operating temperatures greatly reduce the viscosity of the oil. For rough bearings an oil of high viscosity is required to maintain a thick film that will reduce the actual contact of the bearing and journal to a minimum.

Another condition common to general lubrication is that with a circulating or force feed, oil of lower viscosity can be used on account of the increased amount of oil reaching the bearing, which partly compensates for the oil squeezed out. Naturally, the excess oil also tends to reduce the temperature of the oil film and cool the bearing. As a great volume of oil circulated will carry off a large quantity of heat from the bearings the oil does not become highly heated and consequently maintains its viscosity.

Since a number of references have been made to the viscosity of an oil, some explanation of this property may be in order. By the viscosity of an oil is meant its internal friction or resistance to flow. It refers to the same property as do the terms "body" and "cohesion." For true liquids, viscosity varies inversely as the fluidity. The viscosity is usually measured with a viscosimeter, by noting the time required for a given volume of oil to flow through an orifice of definite size under a given pressure. With commercial viscosimeters, such as the Saybolt and the Engler, the tube is too wide and too short for the real friction of the oil to be registered accurately. Consequently, such instruments do not show the true viscosities of oils though they serve a valuable purpose in classifying oils in the order of their viscosities.

Testing The Viscosity of Lubricants

The Saybolt viscosimeter is generally accepted throughout the United States as being the standard instrument for determining the viscosity of lubricating oils. It requires only a small amount of oil for the determination. The time of the outflow of 60 c.c. of oil approximately in seconds is taken as the viscosity of the oil at the temperature used. This viscosimeter requires about 28 sec. for 60 c.c. of distilled water to flow out at a temperature of 68 deg. F. It is to be noticed that the temperature at which the viscosity is taken enters into the final decision as to the actual viscosity of an oil. For this reason the viscosity of a lubricating oil should be tested at approximately the temperature under which it will be required to give service. It would be manifestly an unfair comparison to consider an oil, say for steam-cylinder lubrication, at the viscosity obtained at 100 deg. F. when the actual working temperature encountered might be as high as 400 deg. F.

This line of reasoning should also apply to engine and journal oils. Use of an engine oil, whose viscosity is given in periods of seconds at 70 deg., in a journal whose temperature with safety to the lining could exceed 180 deg., would not be considered, as proper maintenance of the viscosity under the higher temperature could not be expected. As a general rule and if it is possible for relative comparison, 100 deg. is used in viscosity statements by oil manufacturers. The common expression for a certain oil would be 50 sec. of viscosity at 100 deg. F., meaning that it required 50 sec. of time for 60 c.c. of that particular oil to flow through the orifice of a Saybolt viscosimeter at a temperature of 100 deg. F.

From the viewpoint of a practical operator, a lubricating oil should have sufficient viscosity to maintain an adequate film under normal working conditions, plus a sufficient amount of viscosity to prevent the bearings coming in contact during abnormal conditions. The best apparatus for testing oils is the equipment in which it is used. Simple tests with thermometers inserted in bearings during the running periods will give the results that are being obtained.

When selecting an oil for the lubrication of certain bearings, the following points are to be considered:

1. The subject of viscosity, already touched upon.
2. The chemical characteristics of the oil. In other words, is the oil an acid-treated oil from which all traces of acid have not been removed?
3. The natural cleanliness of the oil. Will it leave deposits on the various parts of the bearing or journal?
4. From the viewpoint of economy, what would be its rate of evaporation? Is it an oil that might lubricate successfully under high temperature, having a reasonable amount of evaporation and requiring little replacement and removal?
5. The life of an oil in a certain class of service. Can it be withdrawn repeatedly, filtered and put back into service and give satisfactory results?
6. The price of the oil by unit of sale.

There are many simple tests that any plant operator or engineer can make with apparatus procurable around the average power plant, which will give close approximation of the characteristics of a lubricating oil.

To determine whether an oil is acid-treated, dissolve a small piece of sodium carbonate in water. Pour this solution into a flask along with the oil to be tested. Shake thoroughly. Any precipitation is proof of the presence of acid in amounts proportionate to the amount of precipitation.

For the fire test fill a small metal cup, having no seams and holding about two ounces, three-quarters full of oil. Set this on a gas flame or other source of heat and heat slowly to the temperature required. While the temperature is rising, apply a light to the surface of the oil. When there is a flash, note the temperature. This is the flash point. Keep the cup covered and apply the light or flame between the cover and the oil. Continue the heating to a point where the oil will burn continuously. This is the burning point of the oil.

To make comparative determinations of the viscosity of an oil, take a small seamless brass tube with one end closed by brazing so as to prevent melting. Make a small orifice in the center of the bottom of the tube, about $\frac{1}{64}$ in. diameter. The bottom of the tube should be about $\frac{1}{4}$ in. thick to give the proper length to the orifice. Fill this tube with water and with a stop-watch notice the time required for 60 c.c. of water to flow through the orifice at a temperature of 68 deg. F. Then fill the tube with the same amount of oil and notice the time required for the 60 c.c. of oil to flow through the orifice. The oil time divided by the water time will give a relative expression of the viscosity of the oil.

The specific gravity of the oil can be determined only by means of a hydrometer graduated to the Baumé scale. To reduce to terms of specific gravity use the following formula:

$$\textit{Specific gravity} = 140 \div (\textit{Degrees Baumé} + 130)$$

The tendency of an oil to oxidize when exposed to air is of considerable importance. To make a relative determination of this characteristic procure a piece of polished steel about six inches wide and six feet long and fit it in an inclined position with a rise of one inch to the foot. Upon the highest point place drops of the different oils to be compared, notice the time that they are starting, the amount of the decrease and the rate of progression day after day. The oil that runs the steadiest and goes the farthest is the best.

The presence of gasoline and mineral soap in lubricating oil is undesirable. To determine the presence of these two elements, dissolve 15 drops of the oil in a cup filled with gasoline. Put the mixture in a test tube and add 15 drops of metaphosphoric acid and allow it to settle. If any change takes place, it is caused by the presence of mineral soap or gelatin, which are added to some oils by the manufacturer to give them high-viscosity characteristics.

Taking a sample of oil in a shallow test tube and putting it in a freezing solution of ice brine will give a clear idea of its tendency to solidify and become nonfluid when subjected to low temperatures.

General characteristics of transformer oil should be such that it will have a high dielectric strength. It must have a high flash point to prevent its ignition during the opening of circuit-breakers and the failure of transformers, feeder regulators or electrolytic lightning arresters. Where oil is used for cooling purposes, it must have low viscosity to allow free circulation and must be free from deposit to prevent the obstruction of oil ducts. For use in oil circuit-breakers it must have high viscosity to prevent undue splashing, and in electrolytic arresters it must have high viscosity to permit the formation of a sufficiently heavy oil film.

The dielectric strength of the clean dry oil is usually not less than 40,000 volts when tested between $\frac{1}{2}$-in. brass spheres set 0.15 in. apart, or 22,000 volts when tested between 1-in. disks set 0.1 in. apart. Care should be taken to keep these oils absolutely dry under all conditions. The presence of water in as small an amount as 1 per cent. is sufficient to impair seriously the dielectric strength of the oil.

Any oil for insulating purposes in electric apparatus should be absolutely free from all acids or alkali for the reason that acid or alkali reduces the dielectric strength of the oil, and secondly, acid or alkali is corrosive or destructive in its action on the materials of the apparatus. The oil should be as light in color as possible to permit a good view and inspection of the apparatus submerged in the oil. Its factor of evaporation should be low.

Lubricating greases are used for bearings where the pressure is not too great. Greases are used for lubricating parts of machines and to prevent undue splashing of the oil. The most general type of lubricating grease today in use is the soap-thickened oil made by compounding mineral oil of different grades of viscosity with amounts of lime soap, soda soap or other mineral soaps. The quality of these greases is determined by the character of the mineral oil, kind of soap and amount, friction of the oil, the presence of water in the grease, and lastly by the process of manufacture.

Pulling in Conductors with a Crane*

BY TERRELL CROFT

Some suggestions on how to use a traveling crane to pull large electrical conductors into conduits.

CRANES are available in most industrial plants and power houses of any consequence. They are frequently installed in buildings under construction, assuming that sufficient steel has been erected to

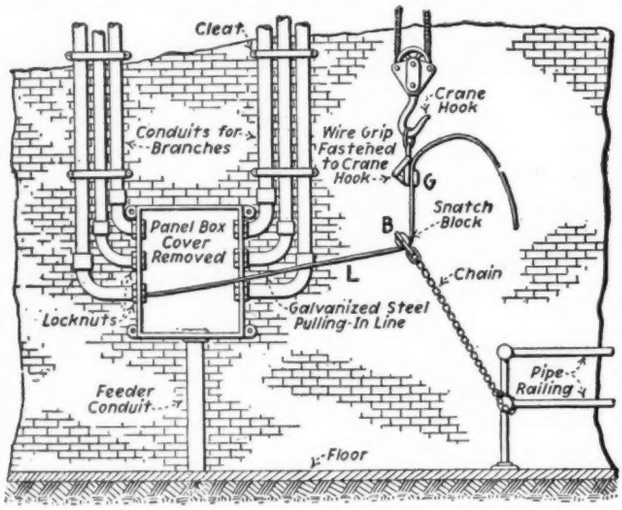


FIG. 1. PULLING IN WIRE WITH A CRANE HOOK

carry them, inasmuch as they are useful in handling construction materials and equipment for the new building. The electrical-construction men and operating engineers can utilize them for the rapid and economical pulling of heavy electrical conductors into conduits.

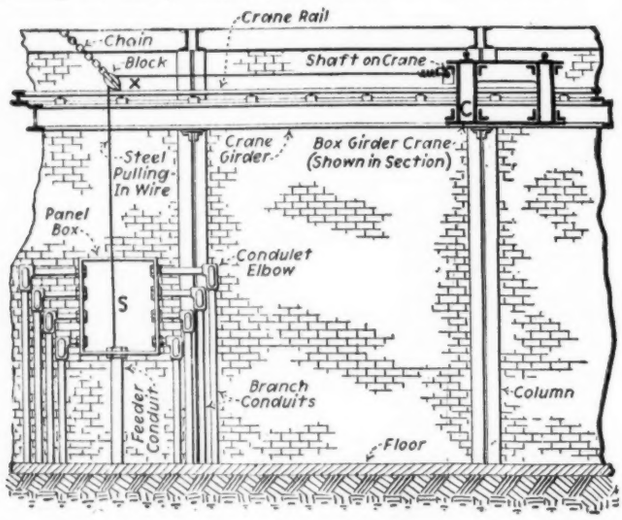


FIG. 2. DRAWING IN CONDUCTORS WITH PULL-IN LINE ATTACHED TO CRANE BRIDGE

A method of pulling in conductors with a crane hoisting hook is given in Fig. 1. The pulling-in line *L* is of galvanized steel. The attachment between it and the crane hook is effected by means of the parallel-jaw wire grip *G*. To insure that the pulling-in line will pass directly out of the branch conduit without excessive binding, the snatch block *B* is arranged and restrained with a chain as shown.

A crane capable of hoisting from, say, 3 to 5 tons at 75 or 100 ft. a minute makes short work of a condition such as that shown in Fig. 2, which presents the arrangement necessary for pulling in a vertical feeder with a bridge crane. A steel wire *S* is used for the pulling-in line. It is attached to the crane at *C*. A snatch block *X* alters the direction of the pulling-in line from the vertical to one parallel to the crane girder. Where feasible, it is preferable to attach to the crane bridge rather than to the hook, because the bridge speed is faster than that of the hook. Furthermore, it is usually possible to pull in a much greater length of wire at one setting where the pulling-in line is attached to the bridge instead of to the hook.

In pulling around a corner with a crane it is necessary to use a snatch block. In a building where there

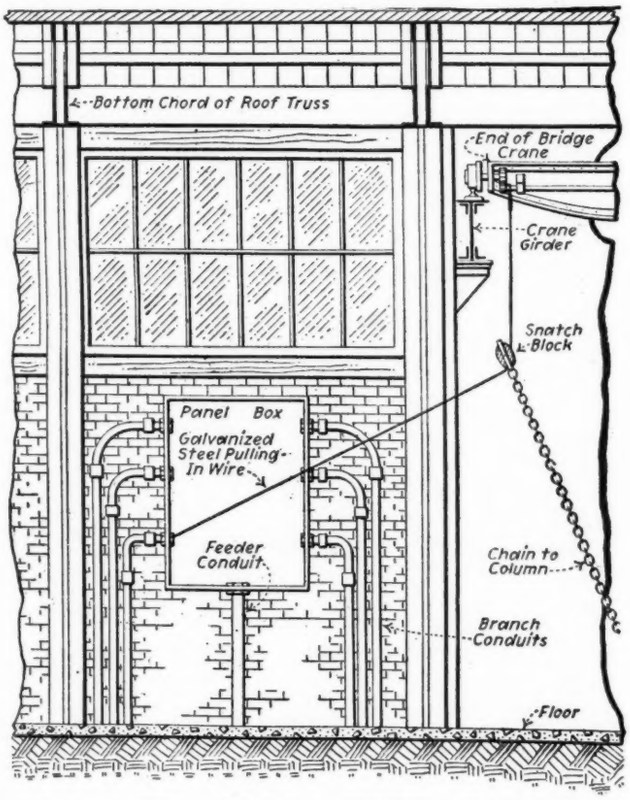


FIG. 3. A PULL AROUND A CORNER. PLAN VIEW OF THIS ARRANGEMENT SHOWN IN FIG. 4

are cranes, it is seldom that any conduit outlet will be so situated that it cannot be pulled from in some way or other by one of them. Several snatch blocks may be required in different cases, but unless too many changes in direction are necessary, it will probably pay to use the cranes. Figs. 3 and 4 (Fig. 3 is a front elevation and Fig. 4 a plan view) illustrate an example where a pull is being made around a corner. The connection between the fishing wire and the crane is the same as that described in Fig. 2: that is, the fishing line is attached to the shaft of the bridge crane.

A sheave mounted in a pull box may be used instead of a snatch block, as in Fig. 5, under certain conditions.

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In the example given in the figure the wooden sheave rotates on a length of ½-in. conduit, which serves as an axle. This axle is held in knockout holes punched in the bottom and in the top of the box for its reception. The expedient suggested is particularly applicable where the pull box or the outlet from which the conductors are to be drawn is located in a corner, as in Fig. 5, where a direct pull longitudinally from the conduit would be impossible. Where such a condition exists, the designer should plan in advance and have the knockout holes to support the axle punch in the pull box when it is made. Monorail cranes may be employed for pulling in wire as indicated in Fig. 6. Cranes of this type are much lighter than those of the bridge type. Hence, on heavy pulls the wheels may slip and spin around on the I-beam monorail. When slipping thus occurs, two or three of the cranes may be coupled in tandem. Or if this expedient fails, the pulling-in line should be rerouted so that the pulling can be done by the crane hook. The hook may be capable of raising 3 to 5 tons.

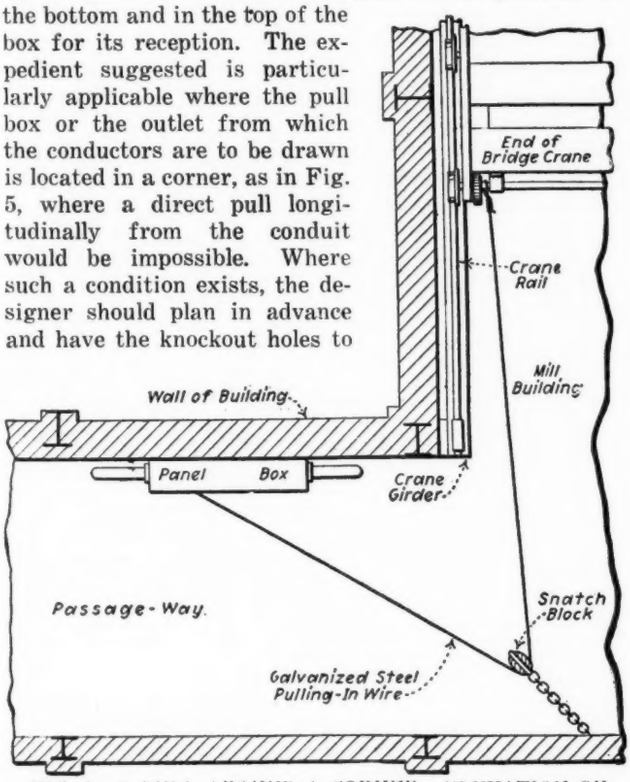


FIG. 4. A PULL AROUND A CORNER. ELEVATION OF THIS ARRANGEMENT SHOWN IN FIG. 3

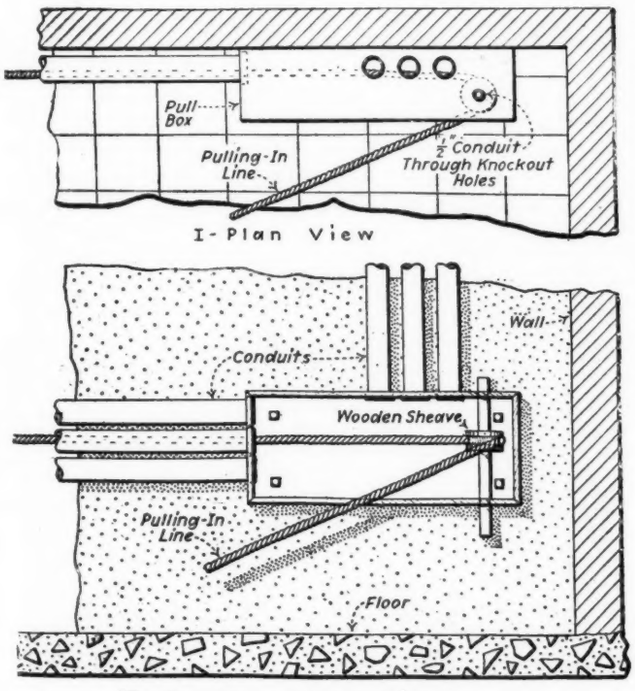


FIG. 5. SHEAVE FOR PULL-IN LINE FOR USE IN CONFINED LOCATIONS

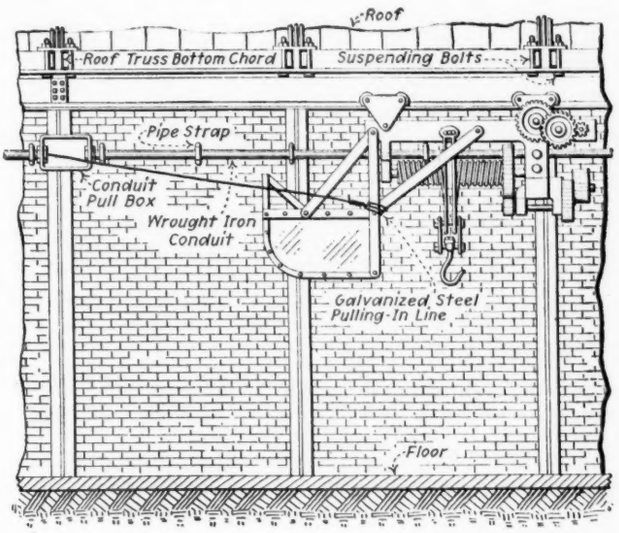


FIG. 6. PULLING IN CONDUCTORS WITH A MONORAIL CRANE

Locomotives, steam or electric, may supply the pulling-in medium. Occasionally, conditions are such that the yard locomotives in industrial or power plants may be thus pressed into service. In certain installations many hundred feet of conductor have been drawn in by this method. It is a satisfying spectacle to observe the ease with which a yard locomotive will haul in conductors which have responded but feebly to the block-and-tackle method.

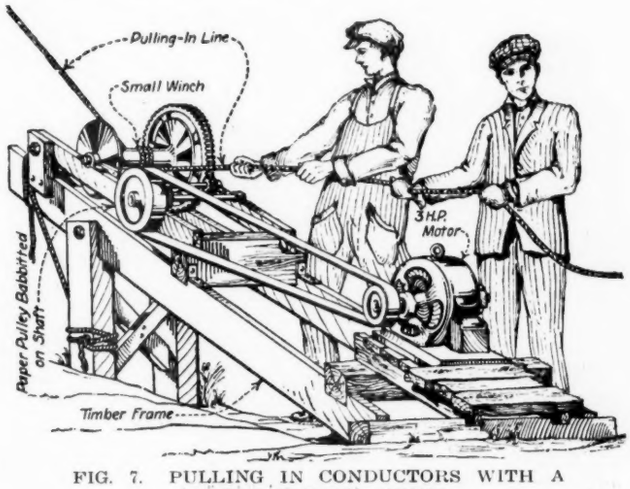


FIG. 7. PULLING IN CONDUCTORS WITH A MOTOR-DRIVEN WINCH

Where none of the foregoing mediums is at hand and there is a considerable number of heavy conductors to be pulled into conduits, it may be possible to make use of a motor-driven winch, as shown in Fig. 7. An old winch was modified by removing the crank and babbitting a pulley to the shaft. Then the winch and the 3-hp. motor were bolted to a couple of timbers. In pulling, the line is given a few turns around the drum of the winch and the motor started. In the meantime the wireman keeps the line taut, as shown.

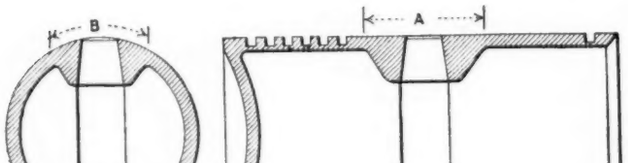
Seized Piston in a Diesel Engine

By D. L. Fagnan

Trouble was experienced through seizing of the piston in a three-cylinder Diesel engine of 225 hp. capacity. For two days the engine had been gradually failing to maintain speed and the exhaust was black, showing that considerable fuel was being used or that the engine was being loaded beyond its capacity. Finally, the engine suddenly stopped with a loud groan and could not be barred over in either direction. The engineer frantically tried to find the cause of trouble, but gave up and called for the nearest erecting man.

A message advised me to drop everything and get on the job quickly. First of all I got a line on the behavior of the engine previous to stopping. This gave me a clue for the purpose of making a diagnosis of the trouble. Next, all front plates were removed from the engine and the crankpin bearings were loosened to give play, so that the pistons could be raised in turn in order to determine which piston had seized.

It was found that the piston of No. 3 cylinder was as solid as iron. So the crank bearings of Nos. 1 and 2 were put normal again and the top gear and head removed from No. 3. Kerosene was poured on top of



PISTON IS GIVEN CLEARANCE OVER THE BOSSES

the piston to help loosen things up a little. One man was set to scraping off the piston head and another to grinding in the valves on all three cylinders. It is our practice always to take advantage of a shutdown to put all the valves and valve seats in first-class condition and to shim up under the piston-pin bearings when necessary, so as to maintain compression.

We tried a hardwood block and a sledge on the seized piston, while a man barred the flywheel, but nothing moved. We then applied a hydraulic jack, placed to rotate the flywheel so as to pull the piston downward, while we worked kerosene past the rings and pumped more of it into the lubricant holes in the cylinder liner. It took considerable pressure from the jack, but finally we observed a slight movement, which meant that the worst was over and that all was clear sailing.

The engine was barred over so as to work the piston up and down a few times, while plenty of graphite and oil was allowed to penetrate to the piston rings. This made it an easy job finally to pull up the piston and its connecting-rod and bring them out on the floor. The pistons and rods are heavy affairs and considerable headroom is desirable; but if only four or five feet of clearance is provided over the engine, as is the case in some plants, the removal of a piston and connecting-rod becomes some job. Clamps must be made of hardwood to hold the rod, and the piston must be supported vertically. The piston pin is then driven out, the piston taken down and then the rod. A better method is to cut a permanent opening in the roof and rig up a gallows. This saves considerable time and labor, and a long trapdoor closes the opening perfectly when it is not in use.

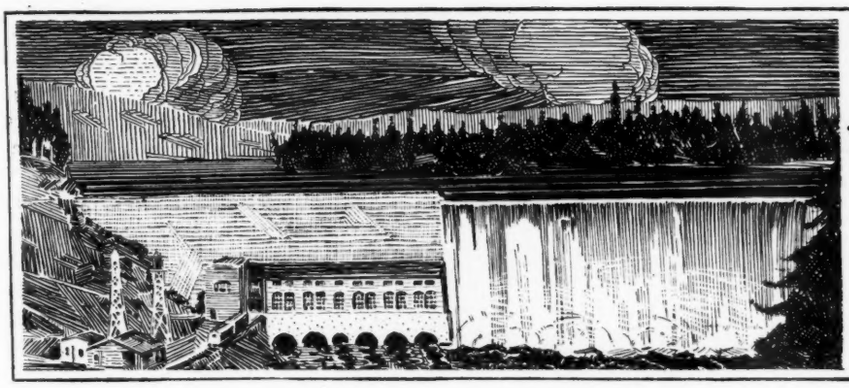
After cleaning the piston with kerosene and gasoline, some very bright spots showed, while abreast of the piston-pin bosses the piston certainly looked chewed up. To my mind, this distinctly indicated a shop error in not providing enough clearance on the piston body at the bosses to permit the expansion that takes place whenever a piston-pin brass is overheated. In the illustration the parts of the piston surface opposite the bosses, as indicated by the areas of length *A* and width *B*, should be provided with clearance while the piston is being made in the shop.

Examination of the cylinder showed some grooving and roughness, and all four lubricant holes practically stopped up with carbon. The use of a half-round file and a scraper, followed by emery cloth on a block of wood curved to fit the liner, made a pretty fair job of smoothing things. This was a five-hour task, but there is no use of doing a poor job on a Diesel-engine cylinder. Good compression is needed to operate at all, and it requires only a small leak to prevent one from getting the 500 lb. per sq.in. needed in such an engine for best results in fuel economy and for parallel operation.

We cleaned out the lubricant holes as well as we could by plugging up three of them and forcing oil through the one left open until it was clear, and doing the same to the others in turn. Then we got busy on fitting a new set of rings to the cylinder liner, while other men set to work to provide clearance on the piston body where it was required. Considerable filing with heavy bastard files was necessary, as 0.02 in. of clearance is required over a considerable area on both sides of the piston. We then fitted the piston rings to their grooves and reassembled the engine. These operations required all day and night without letup.

When we started up again, the engine ran well, so the load was put on and the attendants cautioned to watch the bearings carefully, as these had been keyed up all around; however, no trouble developed. When I told the engineer to remove the other two pistons and give each one the same clearance that had been given to No. 3, he took me to task for not having had this properly done in the shop. I told him it had been done for some time past, but that this was an old engine and the practice was adopted only after reports of piston seizures began to come in.

Apparently, three or four seizures had taken place, which, while serious to the owners of the engine, was but a small percentage considering the number of engines in use; besides, we all learn by experience how to do things better. The piston by caliper gage was 0.006 in. smaller than the liner, which was good practice at the time it left the shop; but it was out of round somewhat and varied from 0.009 in. at one part to 0.015 in. at the smallest part. The front and the back of the piston usually wear most. After a few hours of well-earned rest, I found the engine still running smoothly, so I said good-by to the men all around. These Diesel operators are a fine class of men. They are patient to a remarkable degree, resourceful in emergencies, extremely willing to stay on the job until things are normal, and naturally they get to be fine mechanics, owing to the nature of their work. No botch jobs are tolerated, for each repair must be perfect or it will not be permanent.



POP'S WATER-POWER COURSE

By

John S. Carpenter

"JIMMY," said old Tom Rawlins, the chief of Steam Plant No. 2, "I've got good news for you."

"How's that, Pop?" replied Jimmy, as he caressed the thrust bearing on the No. 4 turbine and decided that it needed more cooling water.

"You mind you said last winter that the Govamint was encouragin' owners of water-power sites to develop 'em. Well, the company has been buildin' two water-power plants up the river on the quiet, to keep it dark from those proppygander fellers, and now there's a bulletin up that they'll give us all a course of lectures from the operatin' man's viewpoint. And, better still, it ain't goin' to be by one of them high-brow fellers that can't talk without gittin' his chin all full of formulers. From those of us that shows the most intelligence, they're goin' to pick the force for the new plants."

JOHN S. CARPENTER

"They might just as well give you one of the plants now," teased Jimmy, "for I can see you burning the midnight oil from both ends of the candle."

"You're darn right, son. S'help me Hanner, I'll git one of 'em! Tonight's the first lecture. Tomorrer we'll review it between ourselves." With that the chief turned into the boiler room to spread the good news.

The company had mapped out a rather interesting course of lectures to be delivered by a hydraulic engineer of the old school, and had arranged to give them so that all the boys would be able to get to them.

The next morning Pop came in to Jimmy with a twinkle in his eye.

"Well, son, how did you make out?" he said. "I thought the feller was easy to understand."

"Ye-e-s," drawled Jimmy, "but I'd like to talk over what he said."

"Well, the first was about the power of a fallin' body. He said that the work in foot-pounds was equal to the weight in pounds multiplied by the distance in feet that it fell through. And he said that power is a rate of doin' work, or the number of foot-pounds of work divided by the time that it's done in."

"I think I see it now," replied Jimmy, "but that rate got me twisted. You mean that we might have millions of foot-pounds of work done in a year and still not have very much done per second or per minute."

"Right," said Pop approvingly. "It would take ten million foot-pounds to pump one million pounds of water up ten feet, no matter how long you took to do it. But it would take a blame sight bigger pump—that is, more horsepower—to do it in an hour than in a week. Work and power ain't the same, by a long shot! A horsepower is 550 ft.-lb. of work done in one second, or 33,000 ft.-lb. done in one minute."

"Now, he turned it into cubic feet of water per second," Jimmy said, "but he did it so quick that I lost track of it."

"Why, that's simple. You see, one cubic foot of water per second fallin' ten feet is the same as 62.5 lb. of water fallin' ten feet; that is, 625 ft.-lb. of work done per second, or $625 \div 550 = 1.136$ hp. So then he gave us the rule: Multiply the head in feet by the number of cubic feet per second and that by 62.5 and then divide by 550; then we have the horsepower that would be developed in a perfect turbine."

"Now, Pop, just a second. The head means the distance that it falls through, don't it?"

"You bet! But if you have cubic feet per minute, divide by 33,000 instead of 550. See?"

"He gave us some simple rules," Jimmy went on. "How did he get them?"

"Well, Jimmy, he said that he simply divided the 550 by 62.5, which gave 8.8, so that the rule could be shortened to: Multiply the head in feet by the quantity in cubic feet per second and then divide by 8.8 That is the horsepower at 100 per cent. efficiency, or the power that a perfect turbine would give."

"That efficiency isn't quite clear to me, Pop. Tell us more about it."

"Son, efficiency is the proportion of output to input, or the answer you git by dividin' the power a turbine gives by what it would give if it turned all the power of the water into work. To git the answer in per cent., you multiply that answer by 100. Now, take a very simple case. Say a turbine gives 75 horsepower and that there's 100 horsepower in the water. Dividin', you git $75 \div 100 = 0.75$; multiply that by 100 and you have 75 per cent., which, by the way, ain't any too good. The feller said that the turbines at our new plant will give 90 per cent. at three-quarters capacity or the builders lose $5000 for each per cent. less."

"That's what I call squeezing the water till it hollers."

"Yes, Jimmy, but it'll save your Uncle Sammy a whole lot of coal. That feller last night said it takes nearly half a car of coal a year to make one horsepower in that time. Our turbines will have a capacity of 10,000 hp., so that saves about 5000 cars of coal a year."

"Now, Pop, what would that constant in his horsepower formula be for 90 per cent. efficiency? I suppose it's different from that at 100 per cent."

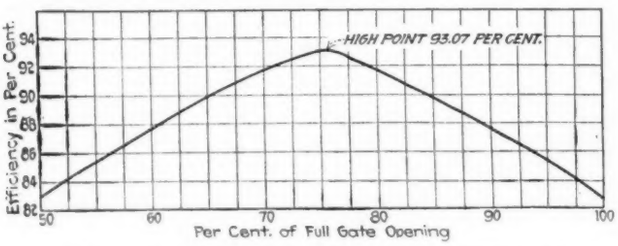
"It is different, Jimmy. I figured out a table for the different efficiencies. Here it is."

TABLE OF CONSTANTS FOR DIFFERENT EFFICIENCIES

Efficiency, Per Cent.	Constant	Efficiency, Per Cent.	Constant	Efficiency, Per Cent.	Constant
74	11.9	84	10.5	94	9.36
76	11.6	86	10.2	96	9.17
78	11.3	88	10.0	98	8.97
80	11.0	90	9.77	100	8.81
82	10.7	92	9.57		

"That's fine!" declared Jimmy. "Now, what I want to know is, do these water turbines have the same efficiency at all loads or is it a case like that old steam turbine down in plant No. 1? She eats up steam like a sieve at light loads, but the steam consumption is less when the full load comes on."

"Yes, Jimmy, it's about the same thing. I ast the feller if he had any efficiency curves with him, and he



RELATION OF EFFICIENCY TO AMOUNT OF GATE OPENING

said he had one. It's from a turbine that broke the record for high efficiency. Here it is; you see the high point of the curve is at 93.07 per cent. at three-quarters gate."

"What does 'gate' mean?" Jimmy asked.

"Why, that means the gates of the turbine were only open three-quarters of the full amount; that is, the gates that let the water into the turbine wheel. Corresponds to the throttle valve on a steam turbine."

"That's blame near as high as the generator efficiencies, Pop."

"You said it!" With that Pop dumped the ashes from his pipe and started off. But he came back in a minute. "Say, Jimmy," he cautioned, "the next lecture's about how they measure the stream flow of the river, the head and how they find the sizes of the turbines. See you don't miss it."

Unsafe Working Conditions

The United States Circuit Court of Appeals, First Circuit, has affirmed judgment in favor of the plaintiff in the case of Gagne vs. Burgess Sulphite Fibre Co., 255 *Federal Reporter*, 872, on account of injuries sustained by plaintiff while entering a boiler room, due to his ignorance of the fact that the stairway which ordinarily formed a means of ingress to the room had been removed.

The plaintiff, although chief engineer of defendant's plant, did not know that the stairway was so constructed as to be portable, for convenience in removing ashes accumulating in the place.

The court holds that it was open to the jury to find "that the defendant was at fault in failing to provide permanent steps, or, in case they were to be removed, in failing to establish reasonable regulations for the safety of its employees; that the plaintiff was not at fault and did not assume the risk."

It was further decided that negligence of a coemployee of plaintiff's might have contributed to the accident, by removing the steps, but that fact would not relieve defendant from liability for negligence in the particulars stated in the last paragraph.

Finding the Efficiency Ratio

BY H. L. DOOLITTLE*

In these days of constantly changing conditions of pressure and superheat in steam-turbine practice it is interesting and instructive to have some common basis on which to compare the performance of various machines. The best method of accomplishing this is by means of the so called "efficiency ratio," or the ratio of the efficiency of a perfect engine, operating on the Rankine cycle, to that of the actual turbine. It will be remembered that the Rankine cycle considers the steam as expanding from the initial pressure adiabatically to the condenser pressure.

If, then, we compare the amount of work actually obtained from a pound of steam with what would have been obtained from a pound of steam expanding in a perfect turbine, we shall have the true measure of the performance of the turbine as compared to the perfect engine. For example, suppose a turbine to be delivering one kilowatt-hour with a steam consumption of 11 lb., initial presure 260 lb. absolute, 200 deg. F. superheat, 28.5-in. vacuum. From a total-heat-entropy diagram it is found that the amount of heat available in one pound of steam with adiabatic expansion (constant entropy) is 412 B.t.u. Hence, with a steam consumption of 11 lb. per kw.-hr. there will be available $412 \times 11 = 4532$ B.t.u. per kw.-hr. As the heat equivalent of one kw.-hr. is 3412 B.t.u., the ratio of the heat equivalent of the work delivered to the heat available is $3412 \div 4532 = 75$ per cent. +. This shows that the turbine is transforming into useful work 75 per cent. of the heat available or is delivering 75 per cent. as much power as would be delivered by a perfect turbine operating under the same conditions.

The accompanying chart greatly simplifies the work of determining the "efficiency ratio." It is in reality a portion of a total-heat-entropy chart with curves superimposed thereon showing the steam consumption per kw.-hr. To use the chart, the vertical distance from the intersection of the curves of absolute pressure and superheat to the curve representing vacuum is taken off with a pair of dividers or on a piece of paper. This distance, representing the heat drop (or heat available per pound of steam between initial and final pressures), is then laid off on the B.t.u. per pound of steam scale upward from the point *A* at the lower left-hand corner. By reading horizontally to the right from the B.t.u. available to the curve giving pounds of steam per kw.-hr. the "efficiency ratio" will be found directly below on the bottom scale.

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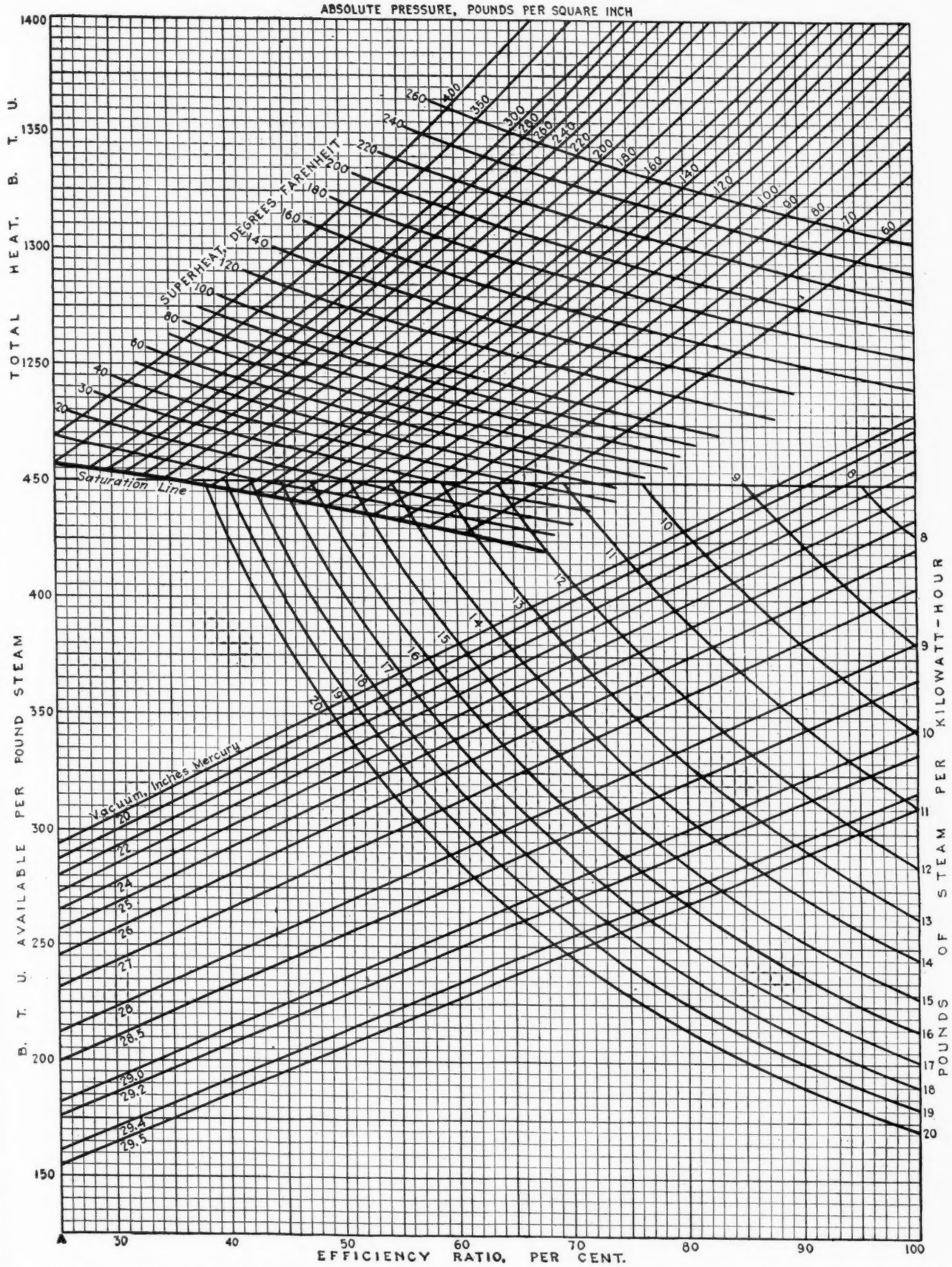


EFFICIENCY-RATIO CHART, CONSISTING OF A PORTION OF A TOTAL-HEAT-ENTROPY CHART WITH CURVES SUPERIMPOSED THEREON SHOWING THE STEAM CONSUMPTION PER KILOWATT-HOUR

Watch the Ammonia Receiver

By JOHN E. STARR
Consulting Engineer, Starr Engineering Company, New York City

The level of liquid in the ammonia receiver is one of the things essential to the successful and efficient operation of the refrigerating plant. Feed only liquid to the expansion coils; but do not judge how well or poorly it is feeding by the sound it makes passing the expansion valve.

IT IS probable that much is said here that is an old story to the operating engineer, skilled in refrigeration. But as we progress in the art, our minds are so likely to be occupied with problems immediately present and imminent, that we forget, momentarily at least, the full significance of simple first principles. This seems to be especially so in refrigerating processes, which include the study of a relation of the large number of variables, always present in heat transfers by themselves, and in the changing of heat into power and vice versa. The average engineer is familiar with the operation of the solid, liquid and gaseous states of water. That is to say, he quickly grasps the behavior of that substance in its solid, liquid and gaseous states, ice water and steam; and many are acquainted with its state as superheated steam.

It seems well, then, in handling more volatile liquids, as ammonia (NH_3), CO_2 and SO_2, to regard them as we do steam except that they have lower boiling points, and to cling to this analogy. Let us get it into our heads that refrigeration is the reverse of steam heating and keep to this idea, and at once many of the apparent difficulties disappear.

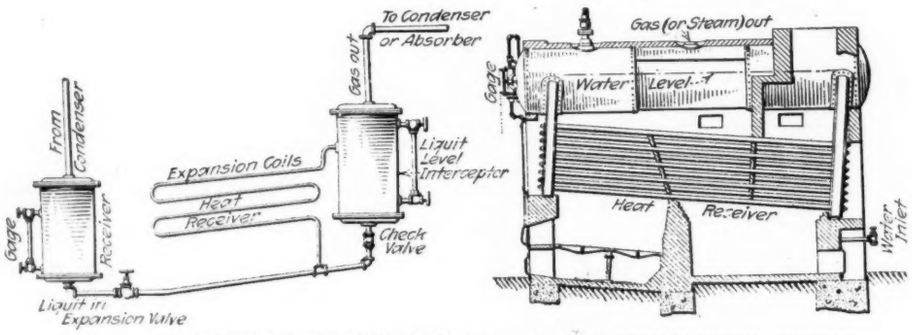


FIG. 1. COMPARISON OF STEAM BOILER AND REFRIGERATING SYSTEM

Keep in view that in steam heating we take a liquid (water) and by adding heat to it we produce a gas (steam) which we convey to a cool place, and by condensing it (as in radiators) we give out heat or warm that place; or by condensing it and so reducing its volume to water volume, or allowing it to escape to a lower pressure, we produce power, and in so condensing it we bring it back to water and repeat the process.

In refrigeration we take a liquid (say anhydrous ammonia, or NH_3) introduce it into a warm place (warmer than the boiling point of the NH_3) and *take up heat*, changing the liquid to a gas. By adding heat to this gas in the shape of power, we put it into a condition where heat can be taken out of it by the condensing water and so reduce the gas to liquid, and repeat the process.

In a sense, therefore, the expansion coils may be likened to a steam radiator *reversed*. In a broader sense, where large quantities are handled, the expansion piping may be likened to a steam boiler, and the analogy is a little closer if likened to a water-tube boiler.

If you took a glass two-thirds full of water surrounded by atmosphere and applied heat to bring its temperature to 212 deg., or over, you would expect it to boil and finally "boil away" into a gas (steam). You would expect that about all the heat would go into the water and that you could not add much heat to the *steam*. That is to say, if the upper part of the glass was the same temperature as the lower part—212 deg. F.—then the upper part would be at the same temperature as the lower part.

Now, take the same glass and pour it slowly two-thirds full of anhydrous ammonia. Surround it with a temperature of 28.6 deg. F. below zero. It will boil from a liquid to a gas just the same as water did, and the whole glass will be at —28.6 deg. F. But suppose you surround the glass with a temperature of say 70 above zero. The lower part of the glass, or up to and a little above the liquid level, will still be —28.6 deg. below zero and will accumulate frost on the outside, because it freezes the moisture in the air; but from a little above the liquid level there is no frost, and the glass, while at a little below temperature of the surrounding air (70 deg.) is not frosted. Why? Because although the gas left the surface of the liquid at —28.6 deg., it became rapidly warmed by the surrounding air at 70 deg. and soon above the liquid level the gas received enough heat through the glass from the air to warm it from —28.6 deg. to above 32 deg. or freezing, and no frost appeared near the top of the glass.

A little heat warms up a lot of gas from —28.6 to 32 deg. while the same amount of heat will boil off some liquid ammonia *at* —28.6 deg. Therefore, wherever the heat goes into the *liquid*, the temperature is —28.6 deg. at atmospheric pressure; and where the heat goes into the *gas*, the temperature is above —28.6 deg., or somewhere between —28.6 and the temperature of the surrounding air, +70 deg. in this case. A short distance above the liquid it rises to above 32 deg. and no frost appears.

Fig. 2 shows about what you would see if you put liquid ammonia into a glass exposed to the atmosphere at 70 deg. F. The ammonia when first dropped into the glass will show below —28.6 deg. because some of it has been "absorbed" or mixed with air and cooled the balance below its boiling point. It will then rise to —28.6 deg. if it is pure, and remain at that point as long as a drop remains. Frost will appear wherever the liquid touches. Shortly above the liquid level the gas would show progressively warmer, and just above the level it would show above 32 deg. and the moisture in the air would not freeze on the outside of the glass.

It is now fairly plain why you would not apply fire *above* instead of below the water line of your boiler. No steam would be made. If you did apply some heat below the water line and some above, all that the heat applied *above* would do would be to superheat the steam and you could get only a small amount of heat through a square foot of steam space surface, while you could get a large amount through a square foot of water-wetted surface. for in the latter case you would be changing a liquid to a gas (great increase in volume) while in the former you would only slightly increase the volume at the same pressure. If you filled the glass with ammonia gas instead of liquid, it is plain that you would not get much refrigeration. So we come to the point.

Look after the receiver and be sure you are feeding only liquid, and no gas to the expansion coils.

You can be sure of this only by looking at the gage-glass on the receiver and being sure that the liquid is

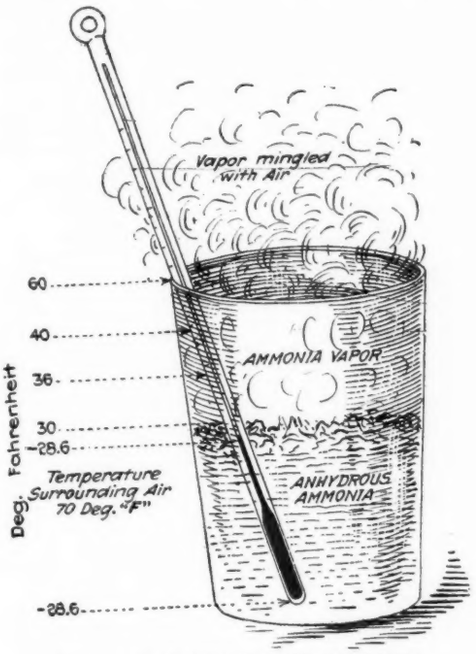


FIG. 2. BOILING LIQUID AMMONIA

always in sight and the expansion valve always flooded; also see that little or no heat is added to the pipe between the receiver and the expansion valve. Do not go by "sound" at the expansion valve. The writer can testify that after listening to expansion valves off and on for 30 years he cannot tell by the "sound" whether nothing but liquid is going through or whether 10 or 15 per cent. of gas is mixed with it.

An instance is recalled in Texas where an operating engineer had for 12 years allowed 10 to 30 per cent. of gas to go through with the liquid because his gage-glass was shut off and he was operating the valve by "sound." The loss in coal represented $43,800 in the period.

The similarity of a well-designed evaporating ammonia system to a water-tube boiler is illustrated in Fig. 1.

In case of ammonia the heat is received into the evaporating coils, which are full of boiling liquid. The "interceptor" catches any liquid that may "slop over" or be temporarily projected forward mechanically and keeps coils full all the time.

Any irregularity in feed is corrected by the "interceptor," and the liquid is returned to the expansion coils. If liquid is always in sight in the receiver and at about the same height (slightly above the level of the top expansion coil), the system is doing all it can.

So if water is supplied steadily at the feed pipe and kept at the same level in the gage-glass of the drum the steam boiler is doing all it can if in both cases the pipes are clean.

The "disengaging" surface (where gas leaves liquid) in both cases must be ample or the liquid will "foam" or be carried forward to either the compressor or absorber in the case of ammonia or to the engine or heater in the case of steam, where it will do no work and may do harm.

The check valve prevents the gas blowing both ways and insures a coil full of liquid. Some prefer to feed into the top of the interceptor and so allow the gas formed to cool the liquid from condenser temperature to evaporator temperature and pass directly to the compressor. This gas, usually 15 per cent. to 18 per cent. by weight, does not mix with gas formed in the coils. The coils are therefore a little more effective per square foot, as the liquid contains less gas and more liquid-wetted surface per square foot of pipe surface.

It is obvious that we would not want to apply heat only at the interceptor, so we insulate it. Neither would we want to apply a fire *only* above the water-line of the steam boiler.

Now, the importance of watching the gage-glass of the receiver is plain, for although the liquid level in the interceptor may be constant, in a pipe system the liquid may be "shoved ahead" by gas and the first part of the system may contain a large proportion of gas and be less effective.

Any of the fluid that passes the expansion valve as a gas does no good, and work, as we shall see, has to be expended on it just the same as if it passed as a liquid.

So the message cannot be too often reiterated—watch the receiver.

A careful tabulation of all the lapses in 32 plants under one management revealed that 89.4 per cent. of all troubles lay in feeding gas through the expansion valve. Were it not for this large percentage, there would have been some hesitation in mentioning so obvious a matter. It is close attention to a few things in a refrigeration plant which means success and continuous service.

Accidents Caused by Unguarded Shafts

Affirming an award of $5000 for the death of an engineer employed at a mine, resulting from his clothing catching on an unguarded portion of a shaft which extended beyond the engine house, the Pennsylvania Supreme Court holds in the case of Carley vs. Dexcar Coal Mining Co., 105 Atlantic Reporter, 651, that decedent was not to be regarded as having been guilty of contributory negligence in passing that particular place. Although he knew the surrounding conditions, it afforded him the only means of ingress to and egress from his place of work.

It is further decided that under the statutes of Pennsylvania requiring dangerous machinery and shafting to be safeguarded, an employee is not to be regarded as assuming the risk of being injured through the condition of shafting left unguarded, although the peril may be obvious.

The Electrical Study Course—Relations Between the Sides of a Right-Angle Triangle

A simple explanation is given of what the terms sine and cosine are and how they are applied to find the length of the sides of a right triangle.

IN DEALING with alternating current the term "sine curve" is frequently met with. Also the word "cosine," especially in regard to power factor, is a common term. To understand what is meant by "sine" and "cosine," it is necessary to give attention to certain relations that exist in right-angle triangles. Right-angle triangles are triangles that contain an angle of 90 deg., as shown at *a* in Fig. 1, in contradistinction to

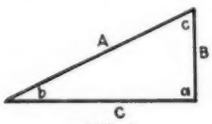


FIG. 1

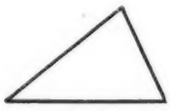


FIG. 2

FIG. 3

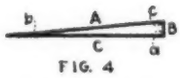


FIG. 4

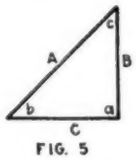


FIG. 5

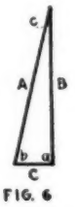


FIG. 6

FIGS. 1 TO 6. TRIANGLES OF DIFFERENT SHAPES

those that do not have, as for instance such triangles as those indicated in Figs. 2 and 3.

It is evident that right-angle triangles may be of a variety of shapes, ranging from a very small to a very large angle at *b*, as illustrated in Figs. 4 to 6. For each possible shape, the lengths of the sides *A*, *B* and *C* are always in the same proportion, whether the triangle be a small one or a large one. Thus, in Fig. 7 we have two triangles, *A B C* and A_1 B_1 C_1, whose shapes are identical, but one of which is larger than the other. The angle *b* is 36.87 deg., and for a triangle of that shape the sides would be in the proportions shown. That is, if *A* is made 10 in., *B* will be 6 in. and *C* will be 8 in. If *A* is cut in half, then both *B* and *C* must be cut in half if the shape is not to be changed. This is shown by the smaller triangle A_1 B_1 C_1, whose sides are 5 in., 3 in. and 4 in. respectively. It will be noticed that the proportion of the sides is the same in both cases. Thus, $\frac{B}{A} = \frac{6}{10} = 0.6$, and $\frac{B_1}{A_1} = \frac{3}{5} = 0.6$; or $\frac{C}{A} = \frac{8}{10} = 0.8$, and $\frac{C_1}{A_1} = \frac{4}{5} = 0.8$, etc. It is therefore apparent that so long as *b* is 36.87 degrees, the values of the fractions $\frac{B}{A}$, $\frac{C}{A}$, etc., will remain the same, irrespective of how long or short the sides of the triangle may be. As already stated, each shape of triangle has its own particular values. For example, when *b* is made 20 deg., $\frac{B}{A} = 0.3420$ and $\frac{C}{A} = 0.9396$; and when it is made 50 degrees, $\frac{B}{A} = 0.7660$ and $\frac{C}{A} = 0.6427$, and so on.

The value of the fraction $\frac{B}{A}$ is called the sine of the angle *b*, and that of the fraction $\frac{C}{A}$ its cosine. These terms are abbreviated "sin" and "cos" respectively. From the foregoing it is evident that the following is true: Sin 36.87 deg. = 0.6, cos 36.87 deg. = 0.8, sin 20 deg. = 0.3420, cos 20 deg. = 0.9396, sin 50 deg. = 0.7660, and cos 50 deg. = 0.6428. The values of the sines and cosines for all values of *b* were many years ago carefully computed and are available in tabular form in various books. The accompanying table gives their value for every angle from zero to 90 deg. It is evident that 90 deg. is the limit, for as *b* increases from a small angle, as in Fig. 4, to a larger one, as in Fig. 5, the side *C* becomes shorter, and as the increase continues it becomes still shorter, as for instance in Fig. 6. The angle *b* would become bigger and bigger, and *C* shorter and shorter, until *b* became almost 90 deg. At the instant it did actually become 90 deg., *C* would

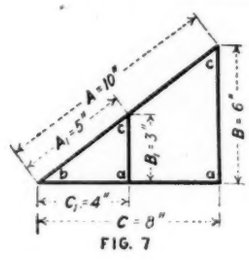


FIG. 7

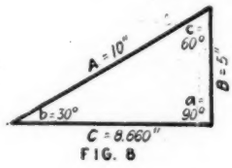


FIG. 8

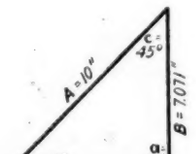


FIG. 9

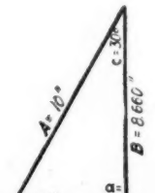


FIG. 10

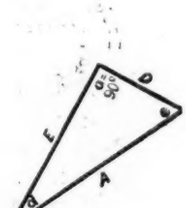


FIG. 11

FIGS. 7 TO 11. SHOW THE RELATION BETWEEN THE SIDES OF DIFFERENT RIGHT TRIANGLES

disappear and *A* would be identical with *B*, after which it would be impossible to increase the angle any further.

Since at 90 deg. *B* is equal to *A*, and *C* is zero, it follows that sin 90 deg. $= \frac{B}{A} = 1$, and cos 90 deg. $= \frac{0}{A} = 0$, the values given in the table. A similar analysis of the conditions when the angle *b* approaches zero, as in Fig. 4, will show that when it does actually become zero, *B* will disappear, and *A* will coincide with *C*, from which we have that sin 0 deg. $= \frac{0}{A} = 0$, and that cos 0 deg. $= \frac{C}{A} = 1$, which values also agree with those given in the table. By means of the table the value of the sine or cosine of any other angle can be determined, or knowing the value of a sine or cosine, the corresponding angle can be found.

In addition to the relation between the sides of a right-angle triangle discussed in the foregoing, there is another one of importance, which is, that the square of the side A is always equal to the square of B plus the square of C. That is, $A^2 = B^2 + C^2$. Thus, in Fig. 7, $A^2 = 10^2 = 100$, and $B^2 + C^2 = 6^2 + 8^2 = 100$; or $A_1^2 = 5^2 = 25$, and $B_1^2 + C_1^2 = 3^2 + 4^2 = 25$. The same relation would be found to hold true, no matter what the size and shape of the right-angle triangle; hence we have a ready means of determining the length of the third side of a right triangle if the lengths of two of the sides are known, as often happens.

There is yet one other property of right triangles that is to be noted, which is, that the angle b plus the angle c is always equal to 90 deg., no matter what the shape of the triangle. For example, in Fig. 7, c would be equal to 90 deg. — 36.87 deg. = 53.13 deg. Hence, if either b or c is known, the value of the other can be found by subtracting the known angle from 90 deg.

In order to illustrate the various relations treated of, their values will be determined in the case of a few

NATURAL SINES AND COSINES

Angle	Sine	Cosine	Angle	Sine	Cosine	Angle	Sine	Cosine
0	0.0000	1.0000	31	0.5150	0.8572	61	0.8746	0.4848
1	0.0174	0.9998	32	0.5299	0.8481	62	0.8803	0.4695
2	0.0349	0.9994	33	0.5446	0.8387	63	0.8910	0.4540
3	0.0523	0.9986	34	0.5592	0.8290	64	0.8988	0.4348
4	0.0698	0.9976	35	0.5736	0.8192	65	0.9063	0.4226
5	0.0872	0.9962	36	0.5878	0.8090	66	0.9136	0.4067
6	0.1045	0.9945	37	0.6018	0.7986	67	0.9205	0.3907
7	0.1219	0.9926	38	0.6157	0.7880	68	0.9272	0.3746
8	0.1391	0.9903	39	0.6293	0.7771	69	0.9336	0.3584
9	0.1564	0.9877	40	0.6428	0.7660	70	0.9397	0.3420
10	0.1737	0.9848	41	0.6561	0.7547	71	0.9455	0.3256
11	0.1908	0.9816	42	0.6691	0.7431	72	0.9511	0.3090
12	0.2079	0.9782	43	0.6820	0.7314	73	0.9563	0.2924
13	0.2250	0.9744	44	0.6947	0.7193	74	0.9613	0.2756
14	0.2419	0.9703	45	0.7071	0.7071	75	0.9659	0.2588
15	0.2588	0.9659	46	0.7193	0.6947	76	0.9703	0.2419
16	0.2756	0.9613	47	0.7314	0.6820	77	0.9744	0.2250
17	0.2924	0.9563	48	0.7431	0.6691	78	0.9782	0.2079
18	0.3090	0.9511	49	0.7547	0.6561	79	0.9816	0.1908
19	0.3256	0.9456	50	0.7660	0.6428	80	0.9848	0.1737
20	0.3420	0.9396	51	0.7771	0.6293	81	0.9877	0.1564
21	0.3584	0.9336	52	0.7880	0.6157	82	0.9903	0.1392
22	0.3746	0.9272	53	0.7986	0.6018	83	0.9926	0.1219
23	0.3907	0.9205	54	0.8090	0.5878	84	0.9945	0.1045
24	0.4067	0.9136	55	0.8192	0.5736	85	0.9962	0.0872
25	0.4226	0.9063	56	0.8290	0.5592	86	0.9976	0.0698
26	0.4384	0.8988	57	0.8387	0.5446	87	0.9986	0.0523
27	0.4540	0.8910	58	0.8481	0.5299	88	0.9994	0.0349
28	0.4695	0.8830	59	0.8572	0.5150	89	0.9998	0.0174
29	0.4848	0.8746	60	0.8660	0.5000	90	1.0000	0.0000
30	0.5000	0.8660						

typical examples. Figs. 8, 9 and 10 represent three right-angle triangles in which the angle b is 30, 45 and 60 deg. respectively. In each case the side A is supposed to be equal to 10. In Fig. 8 angle $c = 90 - 30 = 60$ deg., in Fig. 9 c equals $90 - 45 = 45$ deg., and in Fig. 10 it equals $90 - 60 = 30$ deg. In any right-angle triangle the side B equals side A times sin b, and the side C equals the side A times cos b. Now, if we know A to equal 10 in., from the table we find sin b, which in this case is sin 30 deg., equals 0.5000 and cos $b = 0.8660$, from which $B = 10 \times 0.5000 = 5$ in. and $C = 10 \times 0.8660 = 8.660$ in., as shown in the Fig. 8. To check the results we may add B^2 and C^2, which should equal A^2. Doing so, we have $A^2 = B^2 + C^2 = 5^2 + (8.660)^2 = (5 \times 5) + (8.660 \times 8.660) = 100$, from which $A = \sqrt{100} = 10$, therefore values are correct.

Following a similar course for Figs. 9 and 10, we find from the table that sin 45 deg. = 0.7071 and cos 45 deg. has the same value, also sin 60 deg. = 0.8660 and cos 60 deg. = 0.5000. Then in Fig. 9, $B = A$ sin $b = 10 \times 0.7071 = 7.071$ in., and $C = A$ cos $b = 10 \times 0.7071 = 7.071$ in.; also in Fig. 10, $B = A$ sin $b = 10 \times 0.8660 = 8.660$ in., and $C =$ cos $b = 10 \times 0.5 = 5$ in.

Inspection of Figs. 8 and 10 will show that really only one of them would have been required, since each has a 30-deg. and a 60-deg. angle. Thus, if Fig. 8 were cut out with a pair of shears and pasted directly over Fig. 10, it would exactly cover it. Hence, in Fig. 8, sin 60 deg. would be $\frac{C}{A}$, and cos 60 deg. would be $\frac{B}{A}$. The point that this brings out is that although it is most convenient to represent the angle in the lower left-hand corner as b in Figs. 1 to 10, it is not essential to do so. For example, we might show a triangle in the position illustrated in Fig. 11. Then sin $d = \frac{D}{A}$, cos $d = \frac{E}{A}$, sin $e = \frac{E}{A}$, and cos $e = \frac{D}{A}$.

When we say that the alternating voltage induced in an armature varies according to a sine curve, we mean that the distances above and below the xy line are equal to the sine of the angle through which the armature has turned. This will be presented at greater length in the next lesson.

The problem of the preceding lesson consisted of finding the efficiency of a generator that was driven by a motor, when the load carried by the generator is 225 amperes at 117 volts and the current taken by the motor is 73 amperes at 550 volts, provided it is known that the efficiency of the motor at the given load is 82 per cent. The watts input to the motor is equal to its voltage times its current, so that if P_m represent the input, we have, $P_m = 550 \times 73 = 40{,}150$ watts. Since the efficiency at this load is 82 per cent., the output must be equal to the input multiplied by 0.82. If P be made to represent the motor output, we therefore have, $P = 0.82 \times P_m = 0.82 \times 40{,}150 = 32{,}923$ watts. In this case P is not only the output of the motor; it is also the input of the generator. The output of the generator, on the other hand, is equal to its voltage times its current. If P_g is used to represent the generator output, we have that $P_g = 117 \times 225 = 26{,}325$ watts. The efficiency of any machine being its output divided by its input, in this case $\frac{P_g}{P}$, we find that the efficiency of the generator at the load specified is $\frac{P_g}{P} = \frac{26{,}325}{32{,}923} =$ 0.7996, which, multiplied by 100 to convert it into per cent., gives $0.7996 \times 100 = 79.96$ per cent.

The lower end of a 20-ft. ladder is placed 5.1764 ft. from the wall of a building. How far up the wall will the ladder reach? What angle will it make with the ground? What angle with the wall?

Up to five or six years ago, commercial gas compression plants consisted of the simplest forms of gas pumps, single-stage compressors, and cooling coils. The plants operated only on rich casing-head gas that would produce four to six gallons of condensate with a capacity of not more than 200,000 or 300,000 cubic feet daily. At present plants are in operation treating from 6,000,000 to 9,000,000 cubic feet of gas daily, yielding as low as one gallon of condensate per 1,000 cu.ft., using pressures of 250 and 300 lb. per sq.in. in two stages of compression, with elaborate systems of cooling the gas with water before compression and after each stage of compression. In some plants the gas is further cooled—temperatures as low as 0 deg. F. are often obtained, causing the precipitation of nearly all the condensable fractions commercially valuable for making gasoline.

Flue-Gas Analysis and Co_2 Recorders

By B. M. Baxter

That the CO_2 recorder as a guide to boiler operation and to the prevention of fuel losses is a valuable instrument when its records are properly interpreted and applied, is not open to argument. Nevertheless, it is a desirable apparatus only because we have, as yet, nothing better.

At first thought this may seem a rather radical statement, but let us consider what condition we are seeking to control by the use of the CO_2 recorder. To get a high average percentage of CO_2 in the flue gases, of course. But why?

The idea of maintaining a high CO_2 figure has been so drilled into the minds of power-plant engineers that in many cases the reason for so doing has been lost sight of or forgotten. Taking as a basis the fact that atmospheric air contains roughly 21 per cent. oxygen and 79 per cent. nitrogen (which takes no part in combustion) and that when combustion occurs, the CO_2 resulting occupies the same volume as the oxygen entering into CO_2, it is evident that the sum of the percentages of CO_2 and oxygen should be 21. This is assuming that no carbon monoxide is formed as a result of incomplete combustion. Therefore as the percentage of CO_2 increases, the percentage of oxygen (excess air) must decrease, and it is the excess air which we strive to keep to a minimum.

Influence of Hydrogen

If the foregoing simple condition always held, there would be no fault to find with the CO_2 recorder, but it can only hold true when burning a fuel in which the combustible is all carbon. In all bituminous coals there is a proportion of hydrogen, and it is this which makes the CO_2 recorder of less value than generally supposed. When the hydrogen is consumed. water vapor is formed and in the flue-gas analysis disappears. Instead of a total of 21 for the sum of the percentages of CO_2 and oxygen, in practice the sum may be anywhere from 17 to 20.5, the difference between the figure ob tained and the original total of oxygen being the amount of oxygen that has combined with hydrogen in the coal and disappeared as far as the flue-gas analysis is concerned.

The figure for the total of CO_2 and oxygen will vary according to the condition of the fire when the gas sample is taken, and it will be lower if taken just after firing and higher if the fire is well coked. It will also vary according to the amount of CO_2 contained and will be higher for low percentages of CO_2 and lower as the percentage of CO_2 increases.

This is the reason why the record of the CO_2 recorder is misleading. For example, if the recorder was being checked with an Orsat apparatus, we might make an analysis with a result as follows: CO_2, 12.0; O_2 (oxygen), 8.0; CO (carbon monoxide), 0.0; total, 20.0

As soon as this analysis is completed, we might draw another sample and get this result: CO_2 12.0; O_2, 5.0; CO, 0.0; total, 17.0.

In both these assumed analyses, which would be not at all exceptional in actual practice, the CO_2 recorder would show 12 per cent., and we would have no reason to assume otherwise than that the combustion conditions were the same. Yet in one case twelve-twentieths of the oxygen was used in combustion and there was an excess of 40 per cent. and in the other case twelve-seventeenths was used, so that the excess of air was about 29 per cent. The efficiency of combustion is materially different in the two cases.

Oxygen Recorders Are Needed

We need then, not CO_2 recorders but oxygen recorders, for we care nothing about what the percentage of CO_2 is, except only as it indicates by difference the percentage of oxygen, or, in other words, excess air.

Admitting that this is true, why do we have no oxygen recorders? Presumably because there is known no solution by which the amount of oxygen in the flue gas can be determined without first removing the CO_2, for the solution now used for the determination of oxygen (pyrogallic acid in caustic potash) will also absorb CO_2 and hence the CO_2 must first be removed. It is a problem to put to our chemists to develop such a solution, which will be sufficiently rapid in action to be practicable and can be obtained at as low cost and require no more frequent renewal than the caustic-potash solution now used for the determination of CO_2. If such a solution can be produced, our present CO_2 recorders can immediately be converted into oxygen recorders and the usefulness of their records greatly increased, aside from the inaccuracies of the present recorders as a means to determine excess air.

Owing to the inability of the CO_2 recorder to indicate with even an approximate degree of accuracy the amount of excess air, there is great danger while striving to reduce the furnace losses caused by excess air, to get insufficient air and produce CO in appreciable quantities. The loss resulting from the production of even small amounts of CO may easily overbalance the saving resulting from the attainment of high average CO_2, or, more properly speaking, the reduction in excess air indicated by high CO_2. For each pound of carbon burned to CO there is a loss of about 10,000 B.t.u., hence even small amounts of CO are ruinous to boiler economy.

With the CO_2 recorder there is no means to detect the presence of CO in the furnace gases except that in a properly designed furnace there should be no CO formed except with very small amounts of surplus oxygen. The point at which CO will begin to appear depends on the volume of combustion space and the mixing of the gases in the combustion space. Because of the variation in the amount of excess oxygen that goes undetected by the CO_2 recorder, this instrument is particularly lacking in this respect, and an oxygen recorder would be vastly better as it would indicate without any guesswork just what amount of oxygen was present. Checking with an Orsat apparatus would readily indicate how much the amount of excess oxygen could be safely reduced without the formation of CO.

Effect of Leakage of Air on Reliability of CO_2 Recorders

Another factor greatly affecting the reliability of CO_2 recorders as guides to furnace conditions (and this applies in some measure to Orsat analyses as well) is the influence on the composition of the flue gas of the leakage of air into the boiler setting.

This was strikingly illustrated by analyses made during some evaporation tests conducted by the writer on a water-tube boiler, in which the gases made a single pass through the tube bank. The setting of this boiler had been examined carefully before the test and all visible air leaks stopped. The draft in the furnace aver-

aged 0.015 in. water gage in one test and 0.003 in another, with corresponding drafts at the damper of 0.38 and 0.50 in. These low-draft conditions would tend toward minimizing the infiltration of air into the setting.

Analyses of furnace gases were made from samples taken from the rear of the combustion chamber and simultaneous samples taken below the damper. In one test the average percentage of CO_2 in the furnace gases was 13.1 and the average percentage of CO_2 in the flue gases 10.83. In the other test these figures were respectively 14.4 and 11.8.

The point to be brought out here is that there is likely to be a very considerable infiltration of air under even the best conditions.

CO_2 recorders are usually connected to draw samples of flue gases, not furnace gases. If the setting is not maintained in a condition of exceptional tightness, the records of the recorder will be no reliable index of the conditions existing in the furnace, and a low showing of CO_2 would lead to the belief that excessive amounts of excess air were passing through the furnace, and in the endeavor to correct this supposed condition the air admission might be so reduced that very considerable amounts of CO would be produced with attendant losses.

This condition could also exist with an oxygen recorder, but at least one variable would be eliminated—the undetectable variation in the amount of excess air due to the variation in the amount of volatile and other hydrocarbons consumed.

When samples for analysis are taken from the setting at or near the combustion chamber, the effect of air leaks through the setting is eliminated, but there is no indication of the pressure of such leaks. However, much more reliable indications can be had of the actual conditions of combustion, and accordingly the combustion can be controlled better. Using an Orsat for an occasional analysis of flue gases and comparing the results with the recorded analyses of furnace gases will immediately show whether attention to the setting is needed.

The use of an excess-oxygen recorder for analysis of furnace gases, with an occasional analysis for determination of setting leakage, would give an almost ideal method of determination of efficiency of combustion and a method vastly better than the present CO_2 recorder practice.

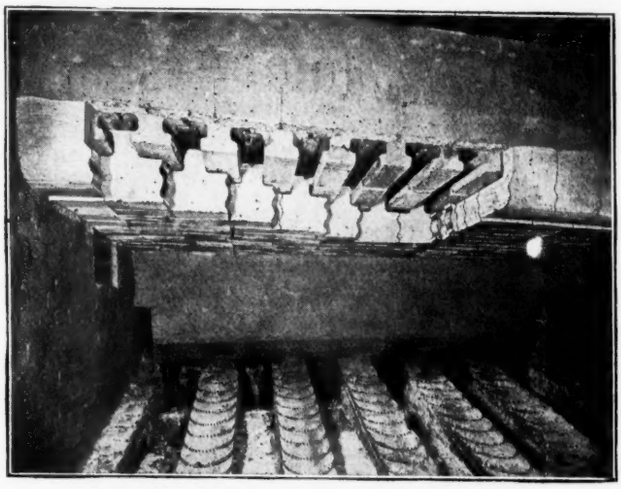
Liptak Double Suspension Arch

Owing to the high volatile and moisture content of bituminous coal the air must be heated to a temperature higher than could be attained by its passage through the fire and by absorption from the side walls. In most cases an arch is needed to ignite the coal in the first place and to maintain a furnace temperature high enough to burn the liberated gases.

The sprung arch has been superseded generally by various forms of flat suspended arches. The principal requirements are proper design, durability, ease of repair, adaptability to any width of furnace, accessibility and avoidance of an enforced shutdown of the boiler.

A new arch that appears to meet these requirements has been developed recently by the Liptak Fire-Brick Arch Co., 844 Builder's Exchange, Minneapolis, Minn. Its distinguishing characteristic is that it is a double suspension arch. This feature consists of a reserve arch over and supporting the lower arch exposed to the fire. The lower tile can be burned away without necessitating a shutdown, as the reserve arch still protects the cast-iron supporting beams and permits the boiler to continue in operation until it conveniently can be taken off the line and a new lower arch installed or the damaged blocks replaced. This is done by sliding in new blocks in grooves of the reserve arch.

At the inner end of the arch the service is more severe, and special precautions have been taken to protect the cast-iron supporting beams. Each beam is equipped with a replaceable tip, so that in the event of the extreme condition that the end blocks burn away, exposing and damaging the supporting members, it will be necessary to replace the tip only instead of the entire beam. Above the end blocks are tile supported independently, so that the lower arch may be renewed without disturbing the rear brick wall. The illustration shows the construction of the arch and the cast-iron supporting members. Between the transverse I-beams supporting the arch the cast-iron supporting members are of tee section. Under the main supports the shape



SHOWING APPLICATION OF ARCH BLOCKS

changes to a modified I-beam section, the upper flanges taking the hangers from the main transverse I-beams and the lower flanges supporting the reserve arch.

An air space between the two arches permits circulation of air, helps to keep the reserve arch cool and adds to the life of the installation. Wavy line joints, with no cement, between the blocks of the primary arch prevent the flame from passing through and attacking the arch above. The blocks are made off center and in successive rows the position of the long end of the block is alternated, so as to produce staggered joints lengthwise of the arch.

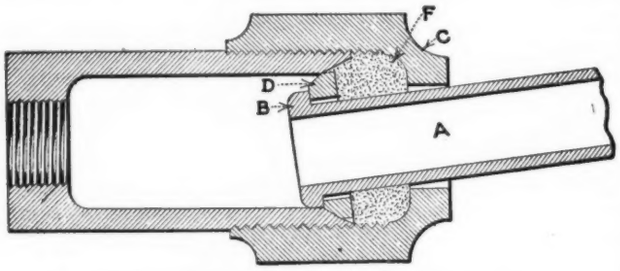
The construction is about three inches deeper than the average single arch and due to the double arch, is more expensive. Longer life and more dependable service are the advantages offered to more than offset the higher initial cost.

Thirty-three municipalities covering a territory about 75 miles in length have organized as the Associated Municipalities of Northwestern Ontario. The principal object in view is to secure electric power from the Provincial Hydro-Electric Commission. A resolution was adopted requesting the commission to proceed at once with the development of power on the Sapgeen River.

Berryman Expansion Union

This union has been designed for the purpose of taking care of expansion and contraction in pipe lines, due to variation of temperatures. It can also be used as a union or as a swivel joint, and it is not necessary to keep a pipe line in a straight line. It is patented by W. F. Berryman, Middletown, Ohio.

The union consists of two pipe members of different diameters, one fitting within the other as shown in the

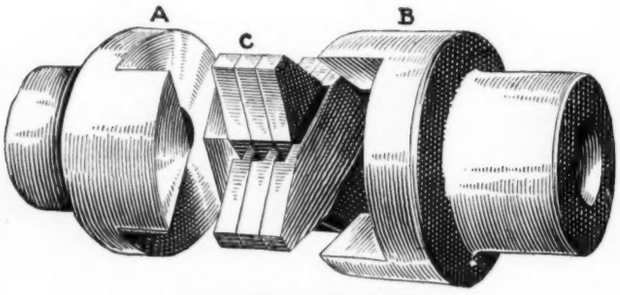


SECTION THROUGH EXPANSION UNION

illustration, which also illustrates the angle at which a pipe line may be connected. One of the pipe sections *A* has one end provided with a flange *B*, the outer edge of which is round. Surrounding this pipe is a gland *C*. A packing ring *D*, with a rounded outer face, is provided and seats on a like surface of the casing. The flat sides of the packing ring compress a packing substance *F* when the gland *C* is screwed up tight. As the opening in the gland is larger than the pipe *A* the latter can be considerably out of line, and still maintain a tight joint.

Uniflex Shaft Coupling

Each design of shaft coupling manufactured has had its own destinctive features. This holds true in the instance of the Uniflex shaft coupling, manufactured by the Uniflex Coupling Co., 246 Chestnut St., Philadelphia, Penn. The coupling comprises two shaft members *A* and *B* and a set of blocks *C*. The shaft members



COUPLINGS AND BLOCKS

are made with jaws that engage each other through the blocks that fit in between the faces of the jaws. The amount of block slides varies according to the displacement of the shaft axes. When the blocks *C* are made solid, or faced with fiber, wood, rawhide, etc., the coupling is insulating, shock-absorbing and does not require lubrication. The coupling can also be made self-adjusting for wear, and it works equally well in either direction. It is relatively small and is designed for any size shaft, horsepower and speed.

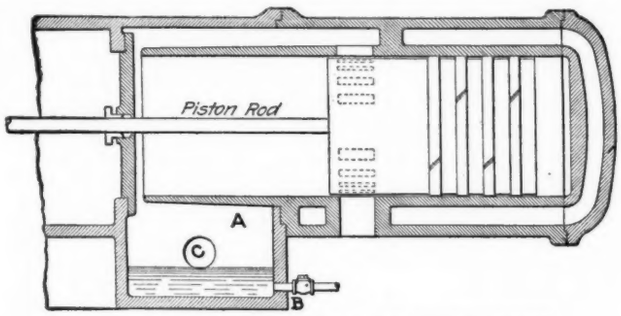
Oil Engine Smokes

By E. E. Snow

Recently the writer was called in to solve the problem of a surface-ignition or low-pressure oil engine that had a decidedly smoky exhaust. The engine was of the hot-bulb type and had the crank end of the engine cylinder inclosed. This acted as the air compressor to furnish the scavenging air to the power cylinder. The engine operated on the two-stroke cycle, and the cylinder construction followed the general lines shown in the illustration.

The first conclusion was that the fuel-pump timing was incorrect, causing the oil to be injected too late to afford complete combustion. This conclusion proved to be erroneous. The next idea was that the ignition device, which was a hot bolt assisted by a hot plate on the piston, did not reach a temperature high enough to ignite the oil. This was not the case, and the opposite stand was then taken—that the igniter was so hot that the oil cracked, depositing the heavier hydrocarbons which caused the smoke. Experiments did not bear out this contention.

Further examination revealed that the excess lubricating oil fed into the cylinder worked to the air end and dripped down into the airbox *A*. There was a plugged opening at *B* which had never been opened.



CYLINDER CONSTRUCTION OF THE ENGINE

The oil had filled this air passage, or box, until it was on a level with the air suction valve *C*. Thus, the air in passing through the valve picked up the oil and carried it in suspension. This air, after being compressed, blew into the power cylinder when the piston uncovered the air ports. The lubricating oil held in suspension was heated up by the exhaust gases and, as it passed out through the exhaust ports, produced black smoke. A ¾-in. drain line was run into the air passage three inches below the air valve. This drain had a check valve opening outward; the check allowed the oil to drain out and prevented the suction pressure from causing a reverse flow. Of course the open drain line caused a loss of air, but this was small and had no effect on the scavenging. The installation of the drain line caused the exhaust to clear up at once.

Immediate steps to rehabilitate the Anderson power plant of the Union Traction Company of Indiana so that adequate and regular service can be given to the cities along the line were ordered June 13 by the Public Service Commission of Indiana. The order is the result of a complaint filed with the commission by a number of prominent business concerns of Marion, who claimed that the poor service was caused by the power plant at Anderson.

EDITORIALS

What Is the Truth About the Coal Situation?

IN AN advertisement imploring the public to buy their coal now, published recently in various daily newspapers, over the name of the National Coal Association, Commercial Bank Building, Washington, D. C., appears the very disquieting statement:

Coal Shortage Coming—says U. S. Fuel Administration; Labor Shortage Pending—says U. S. Secretary of Labor; Car Shortage Predicted—by the Director General of Railroads. Buy Your Coal Now.

This apparently very earnest and conscientious appeal continues:

Listen to and heed what your Government officials say. We are telling you the coal situation as we know it. Moreover, everything we are saying is based upon the official statements of the highest Government authorities.

Forty thousand foreign-born miners are returning to Europe. There is virtually no immigration; consequently the men cannot be replaced. Their departure alone means a reduction of forty million tons in the coal output of the year—twenty million tons for the remainder of 1919.

Government chiefs have issued warnings to buy coal now. Harry A. Garfield, United States Fuel Administrator, warns:

Buy now—in August or Autumn will be too late. A big coal shortage is coming.

Director General Hines, of the United States Railroad Administration, warns the coal consumer that unless he buys coal this summer he is going to find it difficult to get it this fall and winter.

Secretary of Labor Wilson says: Those who postpone buying coal in the hope of lower prices are speculating in the future misfortunes of the nation.

In the New York *Evening World* of July 7 and 8, 1919, were two articles on the coal situation, purporting to be specials from a staff correspondent, that, if authentic, make Ananias look like a piker when compared with this philanthropic National Coal Association. The following are some of the statements appearing in the *Evening World:*

Cleverly placed publicity by the coal interests declares that coal will be very scarce and the public must quickly buy or suffer the terrible consequences, because of labor shortage and like reasons.

As a matter of fact there are now stacked up millions of tons of coal ready for the public to buy. In one section, Landingville, there is one pile of close to one million tons of coal ready for the public, and there are dozens of like mountains of fuel in and around the Schuylkill section.

A hue and cry has been raised that the production this year is so far behind that of last year for the same period as to create a very acute situation. Figures compiled by experts show that the output this year is just about normal, as compared with previous years. Quite naturally, the production of 1919 is somewhat behind that of 1918, because there is now lacking the great incentive of war and the stupendous need for fuel for the conflict.

Having raised the price of coal fifty cents a ton, at the rate of ten cents a month from April on, the coal operators insist the public should immediately buy. There is abundant proof in this section that the coal barons not only shut down their plants in April and part of May to prevent a too plentiful supply of coal and thus a cheaper market, but that a similar shutdown will occur in August. In that month the top price of the fifty-cent jump will have been reached, and the public is not expected to rush in orders. Plans are already perfected to announce then that the public is not buying enough coal to warrant mining.

It is asserted by those who have always been close to mining in this section that the Governmental prices were such as to allow a more than handsome profit to the operators, and that, when fixed, these prices allowed for the raise of pay to the miners. In fixing the fifty-cent jump for this year nothing was added to the miners' pay.

One of the dominant reasons for a probable coal shortage, assigned by the operators, is the labor situation. They declare that the ending of the war has resulted in thousands of miners quitting their work and rushing back to Europe to see the land of their birth. Local officials hereabouts have yet to find one single case of a foreigner leaving his work in the mines to return to Europe.

The claim is made by operators that labor is scarce and that returning soldiers, formerly miners with plenty of experience, have declined to again go down in the mines. Not only is this assertion strenuously contradicted, but plenty of proof exists to show that many returning soldiers have been deliberately turned down when they applied for their old tasks.

Which of the two stories is true? It is evident that both are not, for they are diametrically opposite. If the statements in the advertisement are not correct, are we to believe that members of the President's Cabinet, men occupying positions that rank next to the chief executive of this country, are allowing their names to be used by the coal operators to extort the public. On the other hand, if the truth of the situation is presented by the National Coal Association, is it possible that a great newspaper like the New York *Evening World* can distort facts and cause the statements of some of the country's highest public officials to be open to question, without being brought to account? However, be as it may, if the coal operators had been sincere in wanting to encourage the consumer to purchase coal early, one of the best inducements would have been to reduce the price last April, as in former years, and gradually increase it to normal during the summer months, and save the expense of advertising at the present time. One of the best ways to discourage early buying is the boosting of prices, and this is what was done and production cut down about fifty per cent. so as to delay the purchase of coal until such time as the highest prices could be extorted from the consumer.

Determining Loads with a Graphic Ammeter

DURING recent years the records obtained from graphic meters have become an important factor in the efficient management of many power plants and industrial concerns. Although their principal use is in actual measurement of certain quantities with respect to time, yet a careful analysis of a graphic record will reveal a great many details of the performance of workmen and machines. For instance, assume a graphic instrument to be connected in the circuit of a motor

which runs a milling machine, producing a standardized product. Naturally, the record will show at what time the motor was started and stopped; it will show the power consumed at no load and when loaded. This is valuable information, but the record shows more than this: It tells when the workman started to work; how many cuts he made; the time of each cut and the period between each. It tells if a heavy cut or a light one was made; whether the machine was jammed and the time the operator quits work and whether the motor was stopped or not.

Settling disputes between the customer and the power company is another important duty of the graphic. In fact, the graphic frequently prevents disputes, since the clearness of its authentic record leaves no ground for dispute. A lighting company supplies power to a city's arc lamps, and the municipal authorities make a claim that the lamps were not lighted at certain periods when they should be, and claim a rebate. The company may be equally confident that they were lighted. The expensive calling of witnesses on both sides can be avoided if either side can produce a continuous graphic record to substantiate its claim—the other side could not well dispute the record.

Other uses are in determining maximum demands and the time of their occurrence; locating leaks and theft of current; locating the use of current at unexpected hours and at unnecessary times; determining loads for the addition or rearrangement of motors for more efficient operation; and, in fact, a multitude of uses which constantly present themselves to the alert engineer.

The instruments generally used for this purpose have in the past been heavy, semiportable graphics, usually graphic wattmeters, and their great expense, both initial and in setting up, has greatly discouraged their use except when permanently installed on important circuits. However, there are now available sturdy portable graphic ammeters, which are light, low in cost and easily transferred from one location to another and connected into the circuit without interruption of the service. Of course the results obtained are hardly accurate enough to base the actual power consumption on, nevertheless these graphics produce a wealth of valuable records at minimum expense. In such cases it is not the accuracy of the measured quantity, but the comparative quantities, when they occur, how long and why certain loads occur at certain times, that is of paramount importance in interpreting graphic records of this description. Very accurate records are necessary only when a money value is attached to their indications. These records will be of great benefit to those who wish to record the variations in the loads on their equipment and therefore eliminate waste or arrange for more efficient operation.

Thoroughness in Education

EXIGENCIES of the war led to the development of a form of intensive education, the results of which were highly gratifying, and the experience thus obtained has led in some quarters to the assumption that practically all the courses of study in our educational institutions could be much curtailed to great advantage. While benefit might be derived from such procedure in a few instances, it is doubtful whether it would be advisable to adopt such a suggestion at all generally.

In the very nature of things, a course that is laid out with a view toward expedition and expediency rather than comprehensive thoroughness, will impart to the average student only a superficial knowledge which may carry him along very successfully for a short time in subordinate positions, but which would place him at a serious disadvantage when called upon to hold his place among men really trained in their profession. It is to be borne in mind that the man who graduates from a technical or engineering school is really only about to begin an education that must be pursued ceaselessly. And the more thorough his schooling has been the greater advantage can he take of it.

Of those who have had to acquire their technical education outside of working hours, there are probably few that do not realize the tremendous benefit that would have been derived from a good engineering course. Fortunately, there are available today many opportunities in the nature of night schools and correspondence courses, that add greatly to the possibilities of acquiring a satisfying education in many subjects, but in all cases it requires conscientious and persevering effort to accomplish one's purpose.

The man who is painstakingly working his way through such a course should not let himself be discouraged by the fact that the courses, instituted by the Government during the war, educated men in periods of a few weeks or months to a point where they could be entrusted to discharge duties entailing considerable technical ability. A fact often lost sight of is, that many such men were already equipped with a very good schooling, and many who were not thus grounded fell behind.

Such courses were laid out with infinite care to make the most of the short time that could be devoted to them. They were splendidly conceived and excellently administered, to the lasting credit of all the officials and schools concerned. The work they accomplished was little short of miraculous, but the fact remains that it was what might be called empirical education only, and that the man who is desirous of establishing a reputation should not be misled into the error of abandoning earnest study of the fundamental theory underlying the profession he has chosen to follow.

Watch the Ammonia Receiver

ELSEWHERE in this issue John E. Starr, well-known refrigerating engineer, has an article in which he calls attention to the importance of carefully watching the receiver of an ammonia refrigerating plant. As he says in opening, the subject is an old story to operating engineers. But so is draft and thickness of fuel bed in boiler furnace combustion. And like these, the story must be driven home again and again. What we like about Mr. Starr's article is its plain, forceful presentation. The engineer or student who reads it will never forget why he should be careful to feed only liquid through the expansion valve.

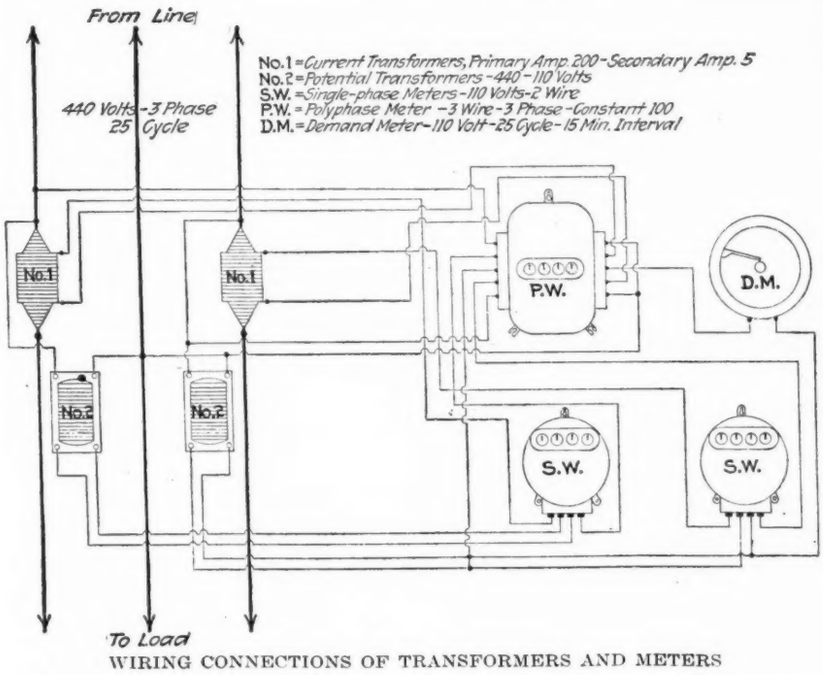
While on this subject we would again emphasize the need of more discussion by engineers of just such aspects of refrigerating-plant operation as is set forth in Mr. Starr's article. As with power plants generally, there must be greater efficiency in the operation and management of refrigerating plants than has been common heretofore. Chiefly by exchange of ideas and practice through the technical press will this end be achieved. What can you add to the progress?

Correspondence

An Interesting Metering Problem

The meter connections shown in the diagram are installed in our plant, for determining the total kilowatt-hours, the average power factor and the maximum demand in horsepower. Can you advise me as to the correct method of determining the following with the meter connections shown?

The average power factor, the maximum demand in horsepower, what would be a fairer wiring; that is, giving if possible higher power factor and lower demand or both? We also take 440-volt current and step it down to 110-volt, through three 10-kw. transformers, delta-connected, for lighting and numerous small heating devices. Would an unbalanced load on the transformers have any effect on the meters, as connected in the diagram, used for determining average horsepower?


From Line
No.1 = Current Transformers, Primary Amp. 200 - Secondary Amp. 5
No.2 = Potential Transformers - 440 - 110 Volts
S.W. = Single-phase Meters - 110 Volts - 2 Wire
P.W. = Polyphase Meter - 3 Wire - 3 Phase - Constant 100
D.M. = Demand Meter - 110 Volt - 25 Cycle - 15 Min. Interval
440 Volts - 3 Phase 25 Cycle
No.1
No.1
No.2
No.2
P.W.
D.M.
S.W.
S.W.
To Load

WIRING CONNECTIONS OF TRANSFORMERS AND METERS

We are penalized on a power factor of less than 80 per cent. What should be the power factor of the current furnished us? Now suppose our average power factor for one month is 70 per cent. and the power factor of current as furnished us is 85 per cent., what would be our power factor if the incoming current had a power factor of 95 per cent? What is the proper method of determining this?

Quincy, Ill. H. R. BARNES.

[The foregoing letter was sumitted to Victor H. Todd for consideration and the following is the answer given.—Editor.]

In the diagram shown in Mr. Barnes' letter the polyphase watt-hour meter *PW* will indicate the total true kilowatt-hours consumed regardless of unbalancing of the load or the value of the power factor. This same amount will be indicated by the algebraic sum of the two single-phase watt-hour meters *SW*. On power factors between 0.50 and 1.00 one of the single-phase meters will run slower than the other, and the sum of their readings will be the power, or kilowatt-hours consumed. At 0.50 power factor one meter stops and the other records the total power. Between 0.50 and 0 power factor, one reads backward, and its reading must be subtracted from the larger reading to get the total kilowatt-hours; that is, the algebraic sum.

The use of two single-phase meters to determine the power factor on an unbalanced circuit or load is absolutely without value, as the same result may be produced by unbalancing as by low power factor. Therefore, if the lamps and heating devices are connected so that the load is unbalanced, the meters may show high power factor on a low-power-factor load or they may show low-power factor on a high-power-factor load, depending on which phase the single-phase load is taken from and the phase sequence of the three conductors.

On a balanced three-phase circuit the average power-factor is easily determined from the formula,

$$\text{Power factor} = \frac{100}{\sqrt{1 + 3\left(\frac{W_1 - W_2}{W_1 + W_2}\right)^2}}$$

in which W_1 equals the larger single-phase watt-hour meter reading and W_2 equals the smaller single-phase watt-hour meter reading. Most companies use a curve, from which the power factor is easily determined from the ratio of the two readings.

The second paragraph is rather obscure, as there can be only one average, or resultant, power factor in any installation, and this depends on the character of the load, not the supply. In other words, the operating company cannot supply a power factor of 0.85 if the power factor of the load is 0.70. The power factor of the supply line before the load is connected to it has nothing to do with what the power factor of the load will be when connected to the supply. If there are two machines connected to the same meters, one may have a power factor of 0.70 and the other 0.90, while the power factor of the supply and that shown on the meters may be anywhere between 0.70 and 0.90, depending on the ratio of the power consumed by the two machines. The only way to raise the power factor of the load is by changing the character of the load. For instance, an induction motor, which has a lagging power factor, may be replaced by a synchronous motor; then if the rest of the load is lagging, the synchronous motor may be adjusted for a leading power factor so as to neutralize

the lagging current and make the power factor of the total load 1.00. Under this condition the meters would indicate 1.00 power factor. This is the condition the operating company desires, and therefore penalizes if otherwise.

As in the case of power factor, the maximum demand is dependent on the load and not the supply; it cannot be lowered by any condition of meter wiring, but can be lowered, if possible, only by changing the time of operation of unit loads so as to obtain a more constant load and not an intermittent peak load. If the dial on the demand meter indicates kilowatts demand, it may be changed to horsepower demand by dividing the kilowatts by 0.746.

The subject of penalizing for low power factor is one of the much discussed present-day problems, as there is no adopted standard definition of "average power factor in an unbalanced three-phase circuit." It is indefinite quantity at present. No power-factor meter will measure it correctly. The nearest approach at present is by using a polyphase wattmeter with three ammeters and three voltmeters in the circuit.

Before changing existing wiring, it would be well to see what the American Institute of Electrical Engineers will adopt as standard in the near future. The writer believes the definition will be somewhat as follows: "The average power factor in a three-phase circuit (balanced or unbalanced) will be the ratio of the real, or true, watts to the apparent watts."

The true watts, of course, are measured by the ordinary polyphase wattmeter. The apparent watts will be the sum of three readings as follows: The product of the current in each line times the voltage measured between that line and an artificial neutral.

In any case, there is no doubt that the A. I. E. E. will adopt definitions and rules for measurement which will clear many misunderstandings and will form the basis for a correct penalty charge for low power factors.

Rainbow Lake, N. Y. VICTOR H. TODD.

Salvaging the Disabled

The spirit of the article published on page 741 of May 13 issue of *Power* is exactly the general attitude and is the one that it is so desirable to change. A point is often overlooked in the fact that there are thousands of partly disabled men (and women for that matter) besides those caused by the war, who must live and often support others. Few of them care to accept charity or alms. Most are able and willing to fit into the industrial system, to become useful members of society instead of a burden upon it and to earn, not ask for, a right to enjoy family life and normal manhood.

The great obstacle is not inability to serve. It is just the attitude expressed in this article; namely, "I don't believe" or "It can't be done." This is the attitude with which an employer tries out the normal man on a job which he claims he can do, but refuses to even listen to the disabled man who wants to prove his ability.

Perhaps a handicapped man could not operate the switchboard under Mr. Peters' charge or a dozen others, but the fourteenth one could. Why should he humble himself, accept alms, be deprived of a normal life, and be a parasite when he can do something useful?

Employers will find that most handicapped men appreciate a suitable job and stick to it better than the average. G. H. BRIDGES.

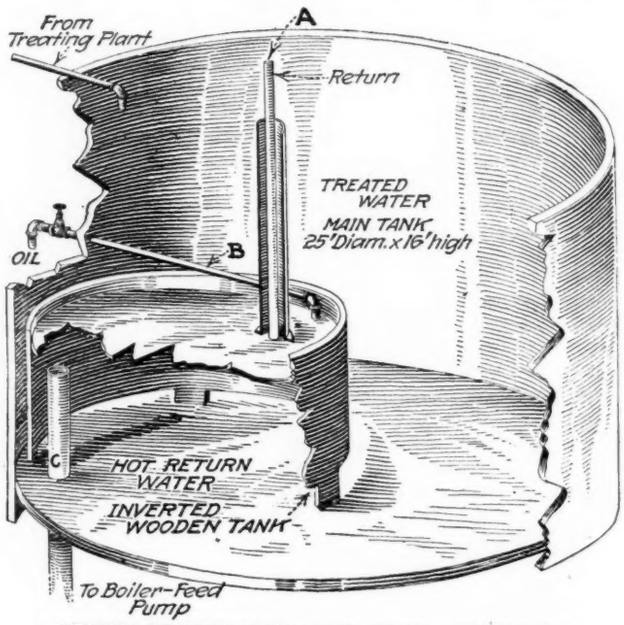
Holyoke, Mass.

Removing Oil from Boiler-Feed Water

The illustration shows the method I worked out to complete the separation of oil from the return water and to retain the heat of the water and return it to the boilers, and also to supply automatically the necessary additional treated water for boiler feed.

After passing through the oil separators the exhaust steam enters the heating coils for heating and drying. The return water is deposited in the inverted tank through the 5-in. pipe *A*, which is incased in a 10-in. pipe, the space between the pipes being filled with 85 per cent. magnesia.

The level of the treated water in the main 25-ft. diameter, 16-ft. high tank is always maintained at or above the top of the inverted tank. The oil remaining in the return water is separated by gravity and can be drawn off from where it collects at the high point at top of the inverted tank, which is set higher at one side than at the other, through pipe *B*. The feed water is taken



DESIGN OF RETURN-WATER TANK AND PIPING

through the inlet of the pipe *C*, which is 15 in. from the top of the inverted tank, to the boiler-feed pump and thence through a closed heater to the boilers.

The hot return water does not mix with the treated water, but like the oil, stays at the top of the inverted tank. The inverted tank is of 2-in. wood and is a fairly good insulator. The deficiency in return water for feeding the boilers is automatically made up by the treated water flowing under the edge of the inverted tank and rising to the outlet of *C* as required. The mixture of return and makeup water is delivered to the pump at from 140 to 150 deg. F.

Originally, the main tank was used for the treated water, the return water from certain branches giving no trouble from oil. The other return water was put through the treating system to remove the oil. We found it very difficult to properly treat the mixture of return and raw water, and practically all the heat was dissipated before it reached the boiler-feed pump.

The system described has been in use over a year, and during that time there has been no indication of oil in the boilers. H. A. WARD.

Cincinnati, Ohio.

Improving a Defective Piping System

On account of scanty headroom above three water-tube boilers and three vertical high-speed compound engines that supply power for an office building, the connecting system of high-pressure steam piping could not be laid out exactly in accordance with correct engineering principles. Figs. 1 and 2 show how the piping was originally planned. The three boilers were connected through 10-in. leads containing expansion loops, to a 14-in. header running along the partition wall between the boiler and the engine rooms. The 10-in. main supply pipe for the three engines was connected to a side opening in the main header, instead of to a top opening as it should have been to secure the best results and as it would have been had not the restriction already mentioned interposed. Steam separators were inserted in the branch pipes running from the main supply pipe to each engine.

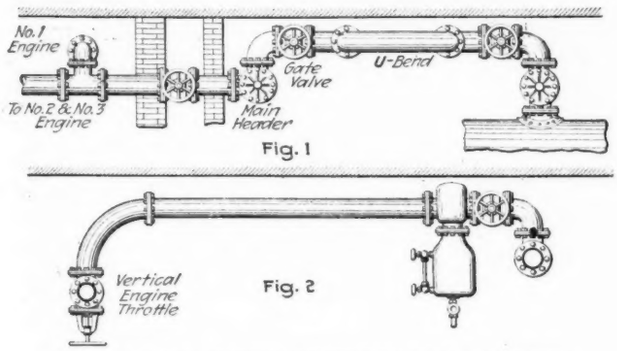


FIG. 1. MAIN PIPING AS ORIGINALLY ERECTED
FIG. 2. BRANCH TO ENGINE IN ORIGINAL LAYOUT

When the plant was started, it was found that the steam entrained an enormous quantity of water. The boilers had to be run with the water barely showing in the gage-glasses to keep slugs of water from getting by the separators in the branch pipes and wrecking the engines. The priming seemed to be more than ordinarily excessive whenever an engine was being speeded up preliminary to cutting it into service. It usually required about twenty minutes or more to accomplish this.

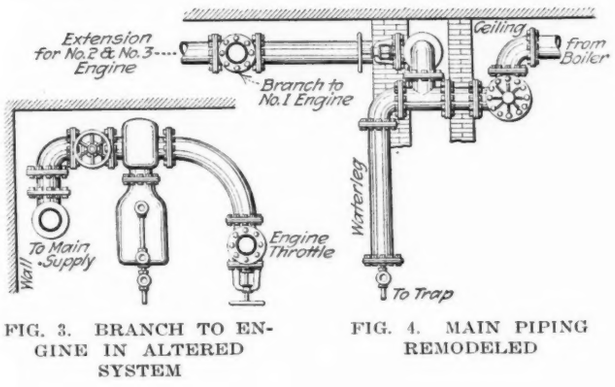


FIG. 3. BRANCH TO ENGINE IN ALTERED SYSTEM

FIG. 4. MAIN PIPING REMODELED

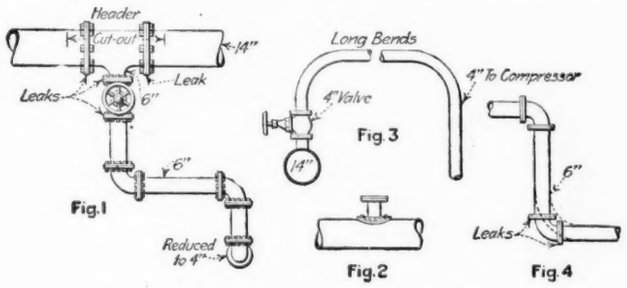
How the difficulty was finally overcome will be understood from Figs. 3 and 4. In the original construction the main supply pipe for the engines ran directly above the three dynamos to which the engines are directly connected. To obviate any possible trouble from leaky joints or otherwise, on this account, it was determined to shift the pipe to the direction opposite from the engine. This was done by branching along the partition wall at right angles to the original course of the piping. To intercept the slugs of water coming through from the main header, it was also determined to insert an amply proportioned separator at the branching point. But the need of running the pipe between the wall and an adjacent supporting column so reduced the available space as to make it impracticable to connect up a regularly designed separator, so that it became necessary to improvise one. Fig. 4 shows how this was done. Fig. 3 shows how the supply branch to each engine appears in the altered system.

The new arrangement works very well. The water-leg, with its connections, makes an effective separator, working on the principle of momentum. Any bulky rushes of water that get into the header are carried by their momentum out of the path of the steam current and into the drop leg, whence they are trapped back to the boilers, while the separators in the branch pipes take care of the lighter entrainment.

St. Louis, Mo. A. J. DIXON.

Leaking Flange Joints

I see in reading the Mar. 4 issue of *Power*, page 325, that F. C. Heylman does not agree with the arguments of many engineers that so many flange connections are the cause of leaks, especially as there are so many good gaskets on the market.



FIGS. 1 TO 4. SHOWING PIPE CHANGES

There can be too many flange connections in any power-plant piping system, and they will cause leaks and will give no end of trouble. I have proof of it in the plant where I am employed. The 14-in. header extends through the engine room, and two large air compressors are piped to it, also a Corliss engine. The original header connection to one compressor is shown in Fig. 1.

In this piping there are ten flange joints and all of the best known gaskets were tried, but none held tight for long. The master mechanic had about 36 in. cut out of the header and then had a piece welded in, as shown in Fig. 2, with a 4-in. saddle connection riveted on this 14-in. piece. Then the job looked as shown in Fig. 3 and the leak was gone.

Another pipe, about 200 ft. long, caused some trouble by leaking at the flanges where it turned through the wall and to the other engine room. The original is shown in Fig. 4. A piece of the 6-in. pipe was cut out on each side of the ell and a long bend welded in place, as shown by the dotted lines. It might be said that there was an expansion joint in this steam line, but it did not prevent leakage at the ell. Since the welded bend was put in there are no joints to leak.

Columbus, Ohio. L. A. COLE.

Short Courses for Engineering Graduates

Regarding the article entitled "Short Courses for Engineering Graduates," by Prof. J. O. Kammerman, on page 731 of the May 13 issue of *Power*, I would like to ask why a prolonged period of training is necessary for young engineering graduates. I know some of the so-called war engineers who have been rushed into responsible positions during the war and have made good, and they are making good today, and some of them will hold their positions.

These young fellows have not been through the cable-dragging course in manufacturing plants, nor chipped iron warts from castings, when their importance was personally most felt, but they delivered the goods during the war and can do so in peace time.

It is discouraging for a graduate engineer to face several years of training, mostly physical, in a manufacturing plant at nineteen cents per hour for the first year and a two-cent increase for the second year and, after having served his two years, to almost know he will have to start out with, maybe, a white-collar job paying $50 a month, on account of lack of experience. Most of the want ads call for at least five years' practical experience in order to get enough salary to eat.

If a young engineering graduate has initiative and some self-confidence, he can make good if the opportunity presents itself. As an illustration, I, together with fifteen engineering graduates from recognized universities and colleges, entered the apprentice course of one of the largest manufacturing plants in the country. This course was the usual one, mostly physical labor, and it was optional with the apprentice as to his learning as he passed from one department to another. Ten of these fellows remained five months and left the plant, three went into the sales department at the end of eight months and two served the two-years' course. In addition to serving two and one-half years, I put in a thousand hours overtime so that I might smoke a really good cigar now and then.

These fellows could not see their way clear to drag cable and wait on workmen month after month without any hope of seeing the test floor inside of a year. One of the men who served eight months took the bull by the horns and today is manager of a district office for a large concern, and it took him only three years to get the job and a good salary. Others did as well.

If a fellow has initiative and self-confidence, I repeat, he can cut out a large part of this prolonged training. As to the older and experienced engineers helping the young engineer along, it cannot be denied that experience is not always the best teacher. Older men can help the young ones over a lot of rough places if they will just take the interest and time to do it.

From personal experience I know that the young man will not always ask questions that he wants to ask lest he expose what he thinks is his ignorance. In one sense it is not his ignorance, but his lack of experience, and the older man could put the young fellow straight in a few minutes, while, on the other hand, it may be a long time before the young fellow gets a chance to put himself straight.

Let the older engineer pay more attention to the seemingly insignificant details brought up by the youngsters and thereby shorten the training period. I make it a point to tell my young associates that asking about what is uncertain or confusing is the easiest and quickest way of getting straight on the subject. I also take time to explain points to the electrician or wireman who shows an inclination to learn. No one knows it all, and asking questions is no sign of ignorance.

Let the older engineer pay attention to the learning wants of the young engineer, and there will not be so many degree men who do not know where to put the equalizer between two compound generators or how to read a potentiometer.

A. W. KOINER.

Norfolk, Va.

Experiences With High-Head Turbines

The account of the failure of a water-turbine case, in a recent issue of *Power*, recalls some experiences I have had with high-head turbines of similar design. In a practically new plant operating under a 175-ft. head the racks at the forebay lacked about 3 in. of being wide enough. A limb 2½ in. in diameter and 14 in. long came through this opening and into the turbine case. When a large motor went short and the governor opened the wicket gates wide, one end of the limb stuck in between the gates. The short threw the circuit-breaker, and as the governor could not shut the gates, the machine began running away. The hand-operated 24-in. valve that let the water into the case was between the wheel and the generator. When the voltage reached 2,600 I threw the exciter switch and started for the valve; but by the time I reached it the speed of the machine had expanded the field poles so much that they were rubbing the armature. Smoke and fire flew, but I finally succeeded in shutting the water off. The field poles had to be taken out and some of them had to be rewound. The armature was not damaged to any great extent.

A short time after that, with a heavy load on the unit, one of the poles broke loose from the spider. The poles were bolted on with 1¼-in. bolts, two in each pole. The machine made about three-quarters of a revolution and stopped. Of course the Lombard governor opened the gates wide; this was a Type R governor with a pressure and exhaust tank, the pump being belted to the waterwheel shaft. With the wheel stopped, the pump could not return the oil from exhaust to pressure tank. The operator tried to shut the gates with the small hand lever and regulating valve, but could not do this as there was as much pressure in front of the piston as back of it. Instead of opening the air valve and letting off the pressure from the exhaust tank, he threw out the clutch that releases the gates for hand control. The gates snapped shut, causing such a surge that, although there were two 18-in. surge pipes on the penstock, it made a 14-in. crack in the flange, where the pipe to the wheel was riveted to the penstock. The bolts in nine of the twelve field poles were found to be sheared off, and all we ever found of the pole that broke first was some of the wire coil. The rest was ground into the armature. This generator was built as an experiment anyhow, and, concluding we had experimented enough with it, we broke it up and installed an up-to-date generator in its place.

With a Lombard governor we always shut the wicket gates in the wheel case before releasing the clutch, as only a small gate opening will cause a violent surge if the gates are allowed to snap shut when operating under a high head.

V. C. WOOD.

Copenhagen, N. Y.

Inquiries of General Interest

Increasing Ammonia-Compressor Speed—If an ammonia compressor is speeded up and the expansion valve is not opened more than before and no more water is turned on, over or through the condenser, what will happen?

B. H. C.

Because of the increased compressor speed, the cooling coils (that is, expansion coils) will soon be emptied of liquid, the pressure therein will be reduced, while the condenser pressure will increase. There will be a slight drop in temperature in the room cooled, owing to the suddenly increased evaporation of liquid in the coils, but as the expansion valve opening is not increased to admit more liquid, the room temperature will soon go up. There is likely to be trouble with the compressor stuffing-box packing.

Capacity of Wooden Tank—What quantity of water would be contained by a wooden tank having inside measurements of 18 ft. diameter at bottom, 17 ft. diameter at the top and 14 ft. deep? J. B. A.

The volume is given by the prismoidal formula; namely *Volume* = 1/6 *depth* × (*area of top* + *area of the bottom* + 4 *times the cross sectional area at mid-depth*). The area of 17 ft. diameter = 17 × 17 × 0.7854 = 226.98 sq.ft.; the area of 18 ft. diameter = 18 × 18 × 0.7854 = 254.47 sq.ft., and as the diameter at mid-depth would be (18 + 17) ÷ 2 = 17.5 ft., the area at mid-depth would be 17.5 × 17.5 × 0.7854 = 240.53 sq.ft., and by substitution the formula becomes

Volume = $\frac{1}{6}$ [226.98 + 254.47 + (4 × 240.53)] = 3368.33 cu.ft., or 3368.33 × 7.48 = 25,195 gal.

Operation of Turbine Governor—With a hydraulic turbine governor, will the governor remain in the same position as long as speed of the turbine is the same, or do the governor weights stand at different positions for different loads on the turbine? W. G. B.

When a turbine is governed by the indirect, or what is commonly called the "relay" method, the centrifugal force of the governor is needed only to "give the signal," which sets in motion an auxiliary mechanism by which the valves are moved by gearing connected to the main shaft or by steam or by hydraulic pressure. The signal is given for more or for less speed, according to requirements and continues until the correct speed is satisfied. There is the same speed and therefore the same standing of the governor weights when the speed is satisfied with one load as with another, within the range of variation required for operation of the pilot valve.

Stream Flow Required for Hydro-Electric Plant—What would need to be the rate of flow of a stream with 16 ft. working head for development of sufficient power with turbine waterwheels for driving one 100- and one 75-kw. generator? S. K. W.

The efficiency of the generators would be about 90 per cent. and the net efficiency of turbines and power transmission would be about 70 per cent., making an over-all efficiency of about 63 per cent., and as 1 kw. is equal to development of 44,240 ft.-lb. per min., then for each kilowatt actually generated, the water would need to develop 44,240 ÷ 0.63 = 70,222 ft.-lb. per min. With 16 ft. head each cubic foot of water used per minute would develop 16 × 62.3 = 996.8 ft.-lb., so that each kilowatt output of the generators would require a flow of water at the rate of 70,222 ÷ 996.8 = 70.45 cu.ft. per min., generation of 100 kw. would require 7045 cu.ft. per min., and 75 kw. would require 5283.75 cu.ft. per min.; or for driving both generators at the same time, the flow needs to be at the rate of 12,328.75 cu.ft. of water per minute.

Striking Atmospheric Pressure Line of Diagram—Should the atmospheric pressure line of an indicator diagram always be drawn on the card and be made before unhooking the cord from the reducing motion, and is it not equally well to strike the line afterward while drawing out the cord by hand? T. A. A.

The atmosphere line is the base line of the diagram, and while not necessary to be taken into account in measuring the diagram, excepting as a convenience, it is necessary for complete interpretation of the diagrams. In all cases the atmosphere line should be struck on the card immediately after diagrams are taken so it will be located as nearly as possible under the same conditions as those under which the diagrams were made. Subsequent drawing of the atmosphere line is likely to give it a false position, and when the cord is drawn out by hand it becomes necessary to "square up" the card to determine the length of a diagram.

Size of Conductors—What size of conductors will be required to transmit 1600 hp., at 0.75 power factor, 15 miles with a loss of 7 per cent. of the power generated in the line; the circuit to be three-phase with 11,000 volts at the generator, conductors spaced 36 in. apart? Also, what will be the per cent. regulation? R. M. S.

With 11,000 volts at the generator the voltage to neutral of a three-phase circuit will be 11,000 ÷ 1.732 = 6350. Assuming 15 per cent. regulation, the volts E to neutral at the receiver end of the line will be 6350 ÷ 1.15 = 5520. The watts W = hp. × 746 = 1600 × 7.46 = 1,193,600, and the current, I, per wire, when the power factor is 0.75, is $I = W \div 3E \times P.F.$ = 1,193,600 ÷ (3 × 5520 × 0.75) = 96 amperes. Allowing the loss in the line to be 7 per cent. of the power generated, the watts loss per wire is $W_n = \frac{W}{3} \times \frac{0.07}{0.93} = \frac{1{,}193{,}600}{3} \times \frac{0.07}{0.93} = 29{,}947$. Resistance per wire = $W_n \div I^2$ = 29,947 ÷ 96 × 96 = 3.25 ohms; and the resistance per mile is 3.25 ÷ 15 = 0.217 ohm. The nearest size standard wire is a 250,000-circ.mil conductor, which has a resistance of 0.2253 ohm, making the total resistance of one wire equal 0.2253 × 15 = 3.38 ohms. With conductors spaced 36 in. apart, the inductive reactance in ohms, at 60 cycles, per mile of single 250,000-circ.mil conductor is 0.626, making a total of 0.626 × 15 = 9.39 ohms.

Knowing the receiver voltage E, the generator voltage E_g is found by the formula,

$$E_g = \sqrt{(E \cos \Theta + IR)^2 + (E \sin \Theta + IX)^2}$$

where R is the resistance ohms and X the reactive ohms of one conductor, and Θ the angle corresponding to the power factor in the circuit. For a power factor of 75 per cent. cos Θ = 0.75 and sin Θ = 0.66. Then

$$E_g = \sqrt{(5520 \times 0.75 + 96 \times 3.38)^2 + (5520 \times 0.66 + 96 \times 9.39)^2} = 6370 \text{ volts}$$

$$\textit{Per cent. regulation} = \frac{E_g - E}{E} \times 100 = \frac{6350 - 5520}{5520} \times 100 = 15 \textit{ per cent.}$$

This value is close enough for all practical purposes. It should be noted that there is no direct method of making these calculations. A certain per cent. regulation is assumed and the calculations made. If this does not come close enough, another value is assumed and the calculation made again until the correct value is obtained.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. —Editor.]

Saving Fuel in Industrial Heating Systems*

A source of easily preventable loss incurred by many factories is that of the use of live steam for heating and for other purposes where exhaust steam would be at least as satisfactory. The manner in which the exhaust-steam problem is handled constitutes the greatest single determining factor in the economy of a steam plant.

LARGE economies are frequently possible in heating a factory. There are many steam-heating systems that consume from two to three times the volume of steam required, as, for instance, by using steam for heating directly from the boiler while wasting enough exhaust steam to supply all heating demands. Assuming a heating system taking steam at the rate of 3000 lb. per hour directly from a boiler, under a pressure of 125 lb. gage, we can, by installing an engine operating at a 30-lb. water rate, develop 100 i.hp. and still leave in the steam about 92 per cent. of its original heat. By supplying directly from the boiler the slight additional amount of steam needed for heating, we gain 100 hp. at the cost of a very slightly increased fuel consumption.

It often happens that a smaller total quantity of steam is used by a properly proportioned engine and heating system operated together than when the engine is not running and the heating demand is supplied by live steam direct from the boilers. The smaller steam consumption with the engine is due partly to the fact that the heating system, designed for the lower temperature, has too large a radiating surface for the hotter live steam, and there is waste through overheating. The reëvaporation loss later discussed is also greater with higher-pressure steam.

Owners Are Prone To Undervalue the Heat Content of Exhaust Steam

Managers and owners have a decided tendency to undervalue the heat content of exhaust steam. Taking the average type of noncondensing factory engine, it is safe to state that over 90 per cent. of the heat supplied at the throttle is available for heating purposes in the exhaust steam. The less efficient the engine, pump or turbine, the greater the percentage of heat contained in its exhaust.

Poorly designed heating systems are responsible for the needless use of live steam to correct faulty circulation, but it is always possible to substitute exhaust for live steam, where poor circulation is the cause of the trouble, by suitably modifying the piping system.

Transfer of heat from the steam to the air or any other substance can occur only when the substance is at a temperature lower than that of the steam, and the rapidity of heat transfer increases as the temperature difference between the two bodies increases. Where the pressure and, therefore, the temperature of the steam is low, a larger amount of radiating surface is required than for the transmission of the same amount of heat by means of high-pressure steam. But it will often be found that low-pressure exhaust steam can be substituted for high-pressure live steam without increasing the amount of radiating surface, provided the original system is susceptible of improvement in the matter of circulation. In a case of this kind exhaust steam at one-half lb. gage pressure substituted for live steam at 20 lb. gage actually increased the heating effect. Bad circulation may be caused by inefficient draining of condensation, steam piping of restricted area and complicated lines, air binding of radiators, etc.

The chief requirements for a good low-pressure heating system are: (1) Removal of oil from exhaust steam; (2) free circulation of steam with least possible pressure drop from the engine to the radiators; (3) continuous and effective removal of air and condensation from coils and radiators; (4) prevention of escape of steam from radiators; (5) the return of all condensation to the feed-water heater. Such a heating system is later described in fuller detail.

Great waste of steam occurs through inefficient steam traps for discharging from radiator units the condensation and air and for preventing the escape of uncondensed steam. Owing to insufficient care and supervision and badly designed traps large quantities of steam are discharged into the drip lines, with a consequent waste of fuel sometimes amounting to 200 per cent. of the amount required under efficient conditions. Oftentimes radiators are found without traps, and hand regulation of the drip valve is depended upon, usually resulting in much waste.

Waste Caused by Using High-Pressure Steam in Heating Coils

When high-pressure steam is used in heating coils, an additional waste ordinarily results from a reëvaporation of a part of the condensed water in the coil upon its discharge through the trap into a lower pressure. This water is practically of the same temperature as the high-pressure steam in the coil, so that when it passes into the lower pressure of the return line a portion of it, depending in amount upon the difference in temperature between the two lines, evaporates into steam which is of no service for heating. It is possible, however, by a special piping and trap arrangement to conserve this reëvaporation for use in the low-pressure portion of the heating system of the plant.

Where exhaust steam is substituted for live steam the saving will be approximately eight times that of returning an equal weight of hot drips. A false impression exists that much less fuel is required to generate steam at low pressure than at high pressure, but as steam at 151 lb. gage has only about 4 per cent. more heat than steam at 1 lb. gage pressure, the fuel required in the two cases varies but slightly.

The rate of transfer from radiators depends partly on their form; the rate increases with increasing difference of temperature between steam and air and also with the velocity of air passing over the radiating surface. In still air this rate is nearly 1.8 B.t.u. per hour with a temperature difference of 142 deg., but several times this value when the air is forced at high velocity over the radiating surface, as in the blast coil heaters of indirect systems. Therefore, this type of heating apparatus requires only a fraction of the radiating surface required in a direct heating system. In water heating by means of steam coils a more rapid transfer of heat obtains. In an ordinary closed type of feed-water heater this amounts to about 180 B.t.u. per sq. ft. per hour per degree temperature difference.

Direct and Indirect Heating Systems Compared

The *direct* system comprises a number of radiators of steam coils located in such a way as to give the desired distribution of heat. Mains and branch lines of piping connect these radiating units to the source of steam supply, and another piping system serves to collect the hot condensation and return it to the feed-water heater of boilers. The regulation of heat is governed by numerous valves attached one to each of the units throughout the plant. These valves are regulated usually by hand, but may be designed for automatic control by means of a thermostatic device. A well-designed direct system is economical of steam and for many sets of factory conditions is more satisfactory.

The *indirect* or blast coil system comprises a fan arranged either to force or induce a current of air through a bank of tubes containing steam and set in a housing from which the heated air is distributed in pipes or flues to the desired locations. Return flues may be specified

*Abstract of Engineering Bulletin No. 6, prepared by the United States Fuel Administration in collaboration with the Bureau of Mines.

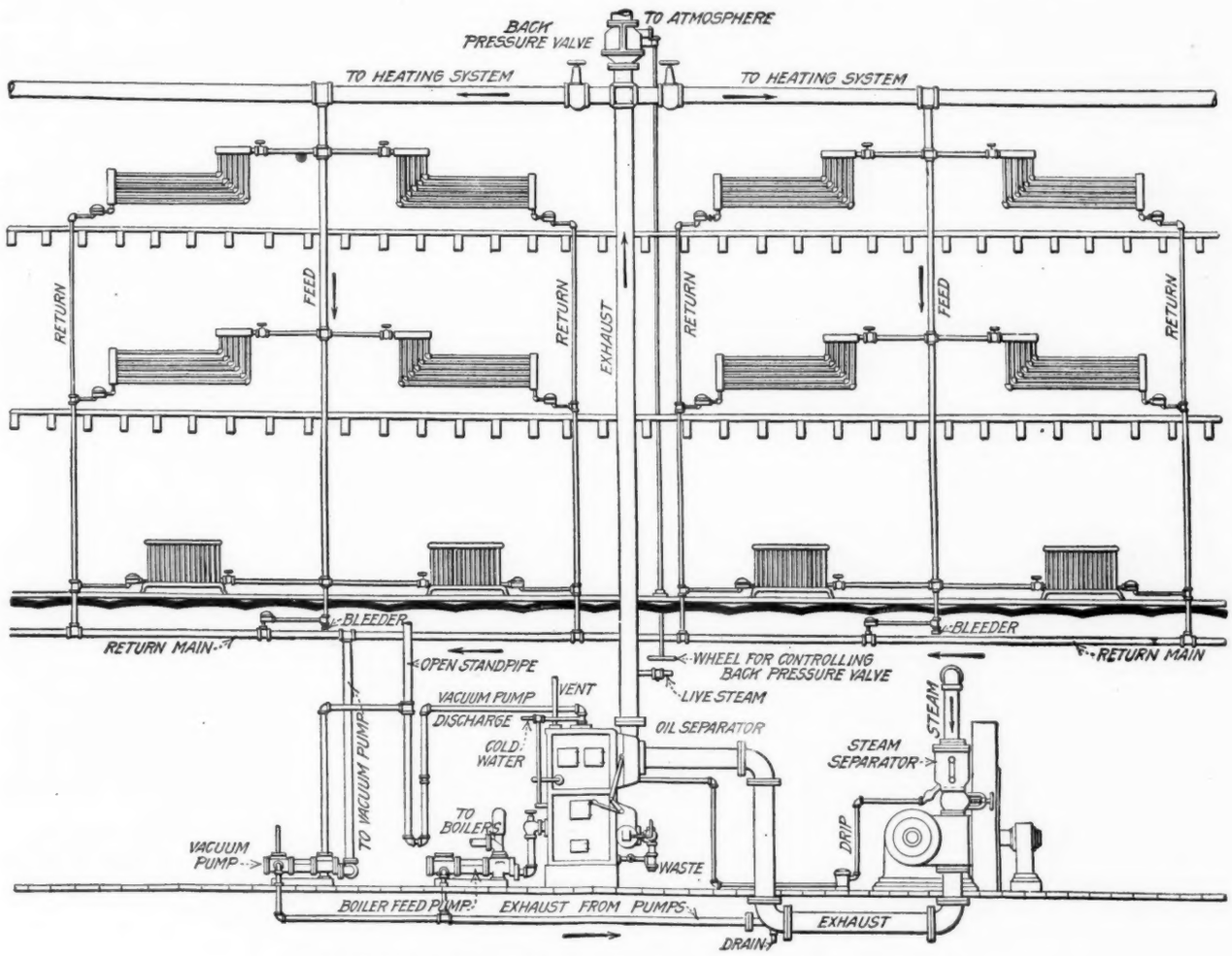
whereby the warm air after its first use is returned to the fan inlet for reheating and continued circulation.

The *indirect* system provides a positive method of ventilation of the buildings and rooms. A specified number of air changes per hour can be effected both summer and winter, and in the warm months the air may be cooled by a water-spray arrangement, thus producing more efficient working conditions for the employees. An engine or motor is required to drive the fan, and the volume of air, the degree of heating or conditioning are under centralized control in the power plant. The amount of radiating surface is much smaller than with the direct system, and drip piping is short and does not extend out of the power-plant department. There are no radiators at distant

and operation. Where a steam plant is used the following rules must be strictly adhered to:

1. Never, if you can avoid it, produce more exhaust steam than can be used at all times of the year, day and night.

2. If noncondensing units cannot be utilized for the power requirements which will at the same time conform to rule 1, then operate noncondensing units only for such time, periods, and loads as will just balance the heating demand, and have a unit or units of the most economical type to carry the balance of the purely power load. The same effect may sometimes be obtained by use of a bleeder type of steam turbine. Sometimes the most economical units for power only may be oil or gas engines.



EFFICIENT LOW-PRESSURE SYSTEM FOR FACTORY HEATING

points, the valves of which might require the attention of the engineering staff. The cost of installation may be either more or less than the direct system, depending upon requirements. The steam consumption of the blast system is greater usually than that of the direct system, owing to the fact that generally more air is heated with a greater number of air changes per hour. Furthermore, a great waste occurs in constantly heating a fresh supply of cold air unless a very efficient return duct system is planned and intelligently used. A direct-connected steam engine forms an excellent drive for the fan, owing to ease of speed regulation, although a variable-speed motor may often be employed. The exhaust from the fan engine is generally piped into the blast-heating coils, where it may be efficiently utilized in cold weather, providing there is not already a surplus of exhaust in the plant.

The handling of the heat problem in conjunction with the power plant of a factory has a greater influence on the over-all economy than any other feature of the design

3. Never use live steam for a purpose to which exhaust steam can be applied.

4. If a plant contains noncondensing units only, maximum efficiency is obtained when the production of exhaust is equal to or less than the heating demand, but never when an excess of exhaust is produced. When less exhaust is made than the quantity wanted, it is proper to draw live steam from the boilers to supply the deficiency.

In laying out the heating design for any industrial plant the first consideration should be the heating of the boiler-feed water with exhaust steam. Then the balance of the exhaust should be applied to the remaining uses. If the water for boiler feed has an initial temperature of 60 deg., about one-seventh of the total boiler output after passing through and performing work in simple engines will be condensed in heating the feed water to a temperature of 212 deg. In a condensing plant the exhaust from the auxiliaries, if properly specified, can be made to balance this requirement. Where no other heating is

wanted, the danger is always that of producing too much rather than too little exhaust for the needs.

An important requirement in connection with the heating system is the separation of oil from the hot water returned to the feed-water heater and boiler. Failure in this regard will probably result in burning, bagging or blistering the boiler tubes or shells. Two methods of elimination are possible, and it is generally advisable to employ both.

TWO METHODS OF SEPARATING OIL FROM RETURN FEED

1. Extract the oil from the steam by use of oil separators inserted in the exhaust piping. Separators should never be specified by the size of the exhaust pipe, but by the quantity in pounds of steam per hour to be cleansed of oil.

2. The second way to remove oil from the feed water is by filtration. Several makes of good oil filters or grease extractors are on the market, which may be inserted in the feed line between the pump and the boiler. Some open-type feed-water heaters include a filter as part of the apparatus and this may assist materially in the elimination of oil from the water.

It is apart from the present purpose to treat in detail the various types of steam-heating systems, but since one type in particular has proved highly efficient for factory low-pressure heating work, a description of its operation will be of value. It will be noted that it provides for those features which have been specified as essential to efficiency. The plan is known as the vacuum return lines system. It is shown complete in all its essential parts in the illustration. Its object is to insure a positive circulation of the steam to all portions of the radiators, to near and distant units alike; to obviate the necessity of carrying heavy back pressures on the engines, to produce this circulation, thus effecting pronounced gains in efficiency and capacity of the prime movers; to remove automatically from radiators all condensation and air as they accumulate and to prevent waste of uncondensed steam.

In addition to these features it is common practice to so arrange a regulating valve that when the pressure in the heating main falls below a predetermined standard, indicating a deficiency of steam for heating, this regulating valve will open sufficiently to make up the shortage by admission of live steam direct from the boilers.

AN EFFICIENT LOW-PRESSURE SYSTEM FOR FACTORY HEATING

Referring to the illustration, the exhaust from the engine leads directly into the feed-water heater giving the first preference of the steam to the heating of the feed water. Combined with the feed-water heater there is an oil separator which is to cleanse the steam before its contact with the feed water or its entrance into the heating system. The remainder of the steam, not condensed by heating the feed water, flows upward to a back-pressure valve which is set to maintain the pressure required for the operation of the heating system, and to discharge to the atmosphere any steam excess. In ordinary practice, the back pressure may be as little as zero to 1 lb. gage at the engine, though with very long exhaust mains it may be necessary to carry slightly heavier back pressures. At a point between the feed-water heater and the back-pressure valve, branch mains carry the steam supply for its distribution to the various units of radiation. Each radiator or coil is equipped with a hand or automatically regulated inlet valve and has a vacuum return-line valve at its lowest point which connects with the return-drip system leading back to the vacuum pumps. The function of the vacuum return-line valves, which operate on different principles according to their make, is to permit the removal of condensation and air and to prevent the escape of steam from the radiators.

Vacuum systems are often found working in a very inefficient manner, even after they have been correctly laid out and installed. The usual cause is the discharge through traps which connect the return line with high-pressure radiation. The action of reëvaporation occurs and fills the return main with steam. Then in order to regain and maintain the vacuum, a cold-water jet near the intake of the vacuum pump is inserted to "kill" the steam. This is a bad practice for which there is no excuse. No high-pressure radiation should under any circumstances be directly connected to a vacuum-return line.

The vacuum pump discharges and returns into the feed-water heater, into which is connected a cold-water makeup supply, automatically governed to supply any deficiency in the feed. The feed pump receives this mixture of heated makeup water and reheated condensation. The vacuum pump maintains a pressure in the return lines of considerably less than atmospheric. (An 8- to 10-in. vacuum is the common practice.) Consequently, if only atmospheric pressure exists inside of the radiators, there is a difference of pressure between the inlet and outlet of each vacuum return valve which acts to discharge the air and condensation from the radiator. Between the vacuum pump and the feed-water heater is a vented tank or standpipe, which serves to free the air from the hot returns before entering the heater.

Each radiator acts as a condenser for the steam supplied to it and causes a reduction of pressure within itself as long as the air and water are continuously removed. This reduces the pressure in the radiators, which may be atmospheric or slightly less, causes a free inflow of steam through their regulating valves and reduces to a minimum the pressure required in the supply main to cause the necessary circulation of the steam. The result is a minimum back pressure on the engine with the attendant economy in its operation. The proper application of the vacuum return-line system may frequently reduce the back pressure sufficiently to increase the capacity of the engine 10 to 20 per cent. with a consequent saving of steam. But the greatest saving is likely to be in cases where its use permits the substitution of exhaust for direct steam.

Hot-Water Heating Boiler Explodes at Camp Mills

The explosion of a sectional cast-iron hot-water heating boiler at the sanitary camp at Camp Mills, Long Island, New York, June 30, was responsible for the death of two men, civilian employees. The accident was caused by the failure of the last section of a six section boiler, used for heating water for shower baths, etc.

An investigation is being made by the officials of the camp, and, although this has not been completed, it has gone so far that they are satisfied that the boiler as regards metal or construction was not at fault.

This boiler was installed since the camp was built, owing to the original boiler capacity being insufficient to supply the needs that is put upon the system, and it is possible that an attendant failed to open a valve, or that the relief valve did not operate, and thus allowed a pressure to build up when the fire was started in the furnace.

Foreign Traders Need Federal Incorporation

A bill to permit the Federal incorporation of companies engaged in foreign trade has been introduced in Congress.

This project is approved by the Government, the American Chamber of Commerce in China, the National Foreign Trade Council and others interested in foreign trade. It aims to remedy the situation now existing in many foreign countries. The need for it is especially great in China, where at present a company formed by Americans and backed by American capital can be incorporated only under the laws of Great Britain or else those of one of the different states. These state laws are so unlike and change so constantly, and court procedure and decisions vary so much in the different states, that the laws are generally distrusted abroad, and it is difficult, often impossible, to secure investment of foreign capital in American concerns organized under these laws.

Samuel T. Wellman

Samuel Thomas Wellman, past president of the American Society of Mechanical Engineers, died suddenly of heart disease, July 11, at Stratton, Me., while on his way to the camp of the Megantic Fish and Game Corporation, of which he was a member.

He was born in Wareham, Mass., in 1837, was educated in the public schools of Nashua, N. H., and attended Norwich University. He was a veteran of the Civil War, having served with the First New Hampshire Heavy Artillery in 1864-5. At the close of the war he resumed his engineering practice. He built the first Siemens gas regenerative heating furnace in the United States, and also the first openhearth furnace for making steel on a commercial scale.

Mr. Wellman became consulting engineer for the Illinois

SAMUEL T. WELLMAN

Steel Co. in 1889, and the following year became interested in a company which bought the works of the Chester Rolling Mills Co., Chester, Penn., becoming its president. Soon after, with his brother, he organized the Wellman-Seaver Engineering Co.

Mr. Wellman was an inventor as well as a promoter, the best known of his patents being the Wellman hydraulic crane and the Wellman openhearth charging machine. In his later years he was identified with the steel industry of the Great Lakes. He was a director and the largest stockholder in the Solid Steel Co., of Alliance, Ohio, and a director and stockholder in the American Wire Co., of Cleveland.

The North American Light and Power Co., one of the largest utility companies in southern Illinois, has purchased the Southern Illinois Light and Power Co., and took charge about June 15. The North American Co., with this newly acquired property will be the largest utility company in the state of Illinois. It will furnish light and power for nearly 200 towns.

International Power Economy Conference

The International Power Economy Conference was organized in Chicago, Ill., Dec. 6, 1918. The object of the conference was to bring together manufacturers of power-plant apparatus with a view of securing aggressive and concerted action by which the United States Fuel Administration might be perpetuated. The conference went on record as indorsing the work of the United States Fuel Administration, and recommended that steps be taken to form a permanent organization.

Subsequently, various committees have been appointed and the work of organization has now reached a point where a program can, with some degree of certainty of fulfillment, be arranged for a conference which will be called at Chicago in October of this year.

The committee to coöperate with the Fuel Administration has been in correspondence with eminent fuel engineers and experts in power-plant efficiency and has submitted as a basis for the present work the proposed plans prepared by David Moffat Myers, until recently advisory engineer of the United States Fuel Administration. An abstract of Mr. Myers' plan follows:

In formulating the campaign of the United States Fuel Administration for conserving fuel along the lines of maximum production of industry with minimum waste of fuel, the consideration of permanence was carefully considered and planned for. Let it be stated clearly that the kind of conservation which will be hereinafter discussed is true conservation, not limitation of industries. In proof of the practicability of true conservation the national plan having the slogan "Maximum Production with Minimum Waste" resulted in a saving of 12,500,000 tons of coal in six months in the power plants of the industries and on the railroads. This is the kind of conservation which deserves permanent life, and it should become a most valuable feature of future government service to the people.

The public at the expense of laborious work and the best economic thought has been taught the idea of conservation and elimination of unnecessary waste. If the effort is now relaxed, the momentum of the movement will never again be regained. Therefore, now is the time to act and the action must be immediate.

Since a permanent service is required, it is natural to look to a permanent branch of the Government. A review of the departments immediately fastens our attention upon the Department of the Interior. The Bureau of Mines is the most authoritative source of information in the country on fuels and their conservation, and the Geological Survey has made careful study and survey of the possibilities of water throughout the country and also the possibilities of extending the use of water power. These two branches of service are coördinated under the Secretary of the Interior and are the logical means for handling this national problem from headquarters in Washington.

It is essential in the proposed plan that an engineer be appointed by the Department of the Interior to hold office in each state, and report to the Department of the Interior in order to keep the Central Bureau of Conservation thoroughly informed on local conditions and problems throughout the whole country, and that all members and officers for the new work be appointed by the Bureau of Mines and that all such appointments be kept clear of local and, as far as possible, of Federal political influence.

The first phase of the subject which should be undertaken is the continuance of the educational and publicity propaganda started by the Bureau of Mines and continued and intensified by the United States Fuel Administration, which would hand over all of its information and facilities as fast as possible.

Among other elements to be desired is an advisory committee including first of all an engineering element made up of members of the four National Engineering Societies, members of the National Labor Organizations, members of the Federal Chamber of Commerce and others to be suggested.

A function of the undertaking should be that of interesting itself in the correct design of new power plants and in supervising changes of power equipment in existing power plants, which do not at the present time always lead to better economy, but should in the future be made to do so. We shou'd also look forward to the future recovery and utilization of the valuable byproducts of coal resulting from low-temperature distillation.

In addition to the 25,000,000 tons of coal annually saved in the industries and railroads alone, other savings have been effected within this same policy of maximum production with minimum fuel waste. Some of these are included in the following table:

	Tons
Railroads	7,000,000
Steam plants	18,000,000
Skip-stop	700,000
Isolated plants	272,000
Water power	196,000
Domestic	400,000
Duplication	48,000
True conservation results	26,616,000

This saving of nearly 27,000,000 tons per year represents the result of only six months of effort on the conservation plan, during which period the connected organization was in process of formation and even now only covers 25 of the 48 states. With complete and permanent organization such as proposed, an annual saving of 50,000,000 tons of coal would be a very conservative estimate in addition to the large possible economies in oil, gas, lignite, etc., contemplated within the plan presented.

The proposed plan should include a broader and more intensified program of education than ever before. In every technical school there should be inaugurated lecture courses on fuel conservation. Educational courses suited to their requirements should be spread throughout the country to include the teaching of the engineers and firemen who run our plants. Very great results have been obtained in the industries and also on the railroads in scientific conservation of fuel and for the good of the country's future must be carried on, intensified and expanded along rational lines.

Shortage of Coal in Europe*

It has usually been thought that with the coming of peace, despite the appalling destruction of French collieries, the difficulty of Europe supplying itself with coal would pass away. The destroyed mines of France produced 20 million metric tons (of 2205 lb.) in 1913, but even this enormous loss of coal-producing capacity represented only 3 per cent. of the total production of Europe which in 1913 was 730 million metric tons, so this loss has a relatively small effect on European coal supplies as a whole; there are other greater factors in the deficiency of production. While there was virtually no destruction of the Belgian coal mines, of which the Germans evidently expected to retain possession, and Silesian, Polish and the Bohemian mining districts have been, and still are, affected by the military fighting, the most important of all effects on production in Europe is that of the general unrest of labor and changes in labor conditions which have brought about a serious lessening of coal production. The cost of production is from 75 to 150 per cent. greater than in 1913, in the various countries, due to tremendous increases in labor and material.

Perhaps the most serious changes, because of the magnitude of the British coal industry, are those taking place in Great Britain, which in 1913 produced 287 million long tons. Great Britain has always been the largest coal-exporting nation of the world. In 1913 it exported 77 million long tons. The output in the year beginning July 16 next, when the miners' working day is to be shortened, will be about 70 million tons less than that of 1913.

If the restrictions in the consumption of coal are removed on the basis of internal consumption of 1913, this would leave but 7 million tons for export. As France, Italy, Sweden, Norway and Spain have largely been dependent on Great Britain for fuel, it can be realized that the situation is serious.

The consumption in France before the war was 62 million metric tons and the production 41 million tons. It imported 18,693,000 tons of coal, 3,010,000 tons of coke and 1,086,000 tons of briquets; exporting 1,742,000 tons of coal, coke and briquets, the total fuel imports exceeded the exports to the amount of 21 million tons. The destroyed mines in northern France produced 20 million tons, so that if the consumption of France within the pre-war boundaries were the same now as it was then, there would be a deficit of 41 million tons.

*From a bulletin issued by the United States Bureau of Mines.

The taking over by France of Alsace and Lorraine and its occupation of the Saar district has materially altered the fuel needs. The Saar produced in 1913, 17,500,000 tons, but the labor situation has lowered the production to the rate of about 12 million tons. Estimates of coal production for the coming year were 28 million tons to 38 million tons, but owing to the shortness of hours and labor unrest, the production may fall below 20 million tons, which was the output of the undestroyed mines before the war.

Contrary to the general impression, the coal mines of Belgium were not destroyed by the Germans. The misapprehension doubtless arises because the Germans did destroy industrial plants, especially iron and steel, in the vicinity of the coal basins. The outlook for immediate improvement in production is not hopeful, although there will be some increase. The total deficiency on a 1913 basis of consumption in Belgium is about 13 million tons.

Of the great allied nations Italy is in the worst situation as regards fuel. In 1913 it produced but 773,000 tons of coal and imported in that year from Great Britain 10 million tons of coal, coke and briquets. During the war its output of low-grade anthracite and lignite was increased to a couple of million tons, but at high cost, to take care of the shortage of import coal.

Spain produced before the war a little over 4 million tons of coal yearly and is said to have increased its output materially during the war. In 1913 it imported from Great Britain 3,649,000 tons. Its natural resources are limited and it must continue to import a large proportion of coal for its consumption.

Holland produced 2,065,000 tons in 1913, but imported about 12 million tons, of which 2,018,000 tons came from Great Britain, the balance chiefly coming from Germany. Norway, Sweden and Denmark produce a negligible quantity of coal, as is also the case in Switzerland, which was supplied from Germany. The former countries imported from Great Britain in 1913, as follows: Norway, 2,298,000 metric tons; Sweden, 4,563,000 metric tons; Denmark, 3,034,000 metric tons; total 9,895,000 metric tons.

The former German Empire was a close second to Great Britain in coal output, producing in 1913 190,109,000 tons of bituminous coal and 87,233,000 tons of lignite (brown coal). The new German Republic will have approximately a yearly production, based on pre-war capacities, of about 124 million tons of bituminous coal and about 90 million tons of brown lignite. There was before the war sufficient surplus coal and coke to send large amounts to Belgium, Holland and France. But in March, 1919, the German coal owners in a conference with the Allies at Cologne declared that owing to the labor unrest and weakened condition from lack of food they had no coal to export over that already going to the "occupied" zones in the Rhine valley.

Political and industrial conditions in Russia, Austria and Poland are still so complicated that discussion of future supplies of fuel is not justifiable. The total deficit in western and southern Europe is estimated to be 50,060,000 long tons.

National Research Council's Bills Before Congress

The House Committee on Patents began public hearings on July 9 on three bills relating to the Patent Office. One of these bills proposes to establish a United States Court of Appeals. The second bill would reorganize the Patent Office, remove it from the control of the Department of the Interior and create an independent bureau to be known as the Patent and Trade-Mark Office. The third measure proposes to revise the salaries and create additional department heads in the patent service. All three of the measures that have been introduced are fostered by the National Research Council.

It is understood that the committee is willing to hear anyone interested and reserves to itself the right to amend the bills, which were drawn by the National Research Council.

New England N. A. S. E. Convention

THE annual convention of the New England States Association of the N. A. S. E. was held in Springfield, Mass., July 8-12, with headquarters at the Bridgeway Hotel. The sessions of the delegates were held in the Mahogany Room of the Auditorium, situated a short distance from headquarters. The basement of the Auditorium was decorated and conveniently arranged for the mechanical exhibit of the New England Association of Commercial Engineers. The booths were occupied by 132 firms, displaying a large variety of power-plant equipment and engineering supplies. The exhibit was liberally patronized during the week.

The attendance of delegates was unusually large this year, every city in the New England States being fully represented. The business of the convention was conducted with harmony and dispatch. Considerable interest was manifested in a paper read by Edward H. Kearney, past national president, which dealt with the responsibility placed upon the engineer at all times, and the important part he plays in the commercial world. He drew attention to the intelligence and watchfulness necessary for him to do his job well. The paper told of the modesty of the engineer, and how his failure to advertise himself led the public to undervalue the importance and responsibility of his work. There is to be an energetic campaign the coming year in New England to boost the membership, and to this end organizers will be appointed and a prize given to the association initiating the greatest number of new members. The report of the state treasurer was most encouraging and places the financial affairs of the association on a sound basis. A vote of thanks was tendered to Walter H. Damon, the chairman of the convention committee, and to the Chamber of Commerce for their aid in making the meeting a success

The preliminary exercises, which included the formal opening of the mechanical exhibition, took place in the Auditorium on Tuesday evening, with Adelbert W. Pettie, president of the Supplymen's Association, in the chair. Mr. Pettie complimented the engineers on the large attendance of delegates, and introduced James W. H. Myrick as the master of ceremonies. Mr. Myrick presented Albert P. Langtry, Secretary of State for the Commonwealth of Massachusetts, who kindly welcomed the convention and told them that he appreciated the reading of the preamble of the organization, and said that for the mutual benefit of the employer and workman a close relationship between them should exist at all times. Major Myrick responded briefly and spoke of the high quality of the members of the N. A. S. E. as men and engineers. Bradford L. Ames gave a short history of the New England Association of Commercial Engineers and complimented the organization on its growth. Mr. Pettie closed the ceremonies and declared the exhibition formally opened.

On Thursday evening the opening ceremonies of the convention were held in the Mahogany Room of the Auditorium, Walter H. Damon presiding. Adolph Gilbert, representing the Mayor, was warm in his welcome to the delegates and visitors, and said that the past war would bring the engineer more prominence and appreciation. State President Andrew Waite spoke of the good quality and high standing of the members of the N. A. S. E. Adelbert W. Pettie said he was glad of the pleasant relations that existed between the engineer and supplyman in the New England States. Joseph Eccleston said that in the immediate future the engineer must be on the jump for greater production, which means higher wages. William J. Reynolds said that the war had fully demonstrated the efficiency of the American engineer and machinist, and that the German ships now operated by the United States are making faster time and are carrying bigger loads than ever. President Waite then appointed the necessary committees and the meeting adjourned until Friday, 10 a.m.

During the week there were several auto rides, shopping parties, sight-seeing trips and theater parties for the ladies. On Thursday and Friday evenings there was dancing in the Mahogany Room of the Auditorium. On Friday evening there was an entertainment in the Auditorium, by Billy Murray and Lou Serre, of Jenkins Bros.; James Donnelly, of the Lowell Association; Bob Jones, of the France Packing Co.; Jack Armour, of *Power*, and four enjoyable vaudeville acts. The entertainment was preceded by an organ recital by Arthur Turner, of Springfield.

SOME OF THOSE ATTENDING THE ANNUAL CONVENTION OF THE NEW ENGLAND STATES ASSOCIATION N. A. S. E.

On Saturday morning the company took a boat ride to Riverside Park. There was a ball game between the engineers and supplymen, and other sports. The festivities wound up with an old-fashioned Rhode Island clambake.

At the closing session of the delegates the following state officers were elected: Warren H. Goodrich, president, Stamford, Conn.; Elmer Dean, vice-president, Springfield, Mass.; Truman L. Tyler, secretary, Taunton, Mass.; Walter H. Damon, treasurer, Springfield, Mass.; John R. Graham, conductor, Fall River, Mass.; Charles Wolf, doorkeeper, New Bedford, Mass. The officers were installed by Past National Presidents W. J. Reynolds and Herbert Kelsey.

The New England Association of Commercial Engineers elected its officers as follows: Harry A. Atkinson, president, Charlestown, Mass.; A. H. Merrihew, Boston, Mass.; James W. H. Myrick, treasurer, Boston, Mass.; Charles F. Ceilley, William J. Naughton, Adelbert W. Pettie, directors.

National Vice-President John J. Calahan, of New Jersey, gave a short address at the entertainment on Friday night, and between the acts gold wrist watches were presented to retiring President Waite and retiring Secretary Henderson of the engineers, and a solitaire diamond ring to retiring President Pettie of the commercial engineers.

Worcester, Mass., was selected as the next convention city in July, 1920.

Railroad Tube Through a Mine Shaft

A feature of the $6,000,000 power plant now being erected at Springdale, Penn., by the West Penn Power Co., is the construction of a tube under the Allegheny River. A vein of coal extending under the river at this point will be mined by the company. As the coal is removed, the shaft will be finished to make it suitable for a double-track railroad tube. The tunnel will be used to convey coal to the plant, which is equipped to consume 40 tons per hour.

One of the many freak vessels produced by the British during the war is the floating electric power station officially known as "C. D. 258," says *Indian Engineering*. Its function was to supply electric current as and where required for the miscellaneous operations in connection with docks, harbors and canals used for military transport. At a distance this vessel might pass for a gunboat without guns; technically, it is described as a steel barge. Amidships is a complete electric power station of 1000 hp. designed so that practically any type of electrical installation can be fed from this source. Two oil tanks, each with a capacity of 20 tons, and an electrically driven workshop with lathe, drilling machine and other repair plant, complete the main part of the equipment. While this universal electric provider is the direct outcome of war conditions, similar equipments are likely to be very useful in the construction of sea and river works. They are also worth considering for the permanent supply of electricity to riverside towns, where, owing to the nature of the subsoil and other local conditions, an ordinary power station would be difficult to erect on a site convenient for water and fuel supply. In remote parts of the world a floating oil-power electric station could probably be installed and run much cheaper than a land station.

Men who try to do something and fail are infinitely better than men who try to do nothing and succeed.

In the several Swiss and French technical journals an account has been given of some passenger cars intended for use on the railways in Saxony and Prussia, which have some features of interest, says the *Electrician*. On these cars the Dieselmotor is directly coupled to a dynamo which in turn supplies motors equipped with separate excitation on the Ward-Leonard system. There are cabins at each end of the cars, the engines being in the middle, and a total of 80 passengers seated can be accommodated. The weight of the complete car, unloaded, is 64 tons. The Diesel motor is rated at 200 hp., working at 440 r.p.m., and can give up to 250 hp., at short overload. A speed of 45 miles per hour is obtained on the level. The generators coupled to the Diesel engines are of the 8-polar type and are rated at 190 kw. hourly and 140 kw. for continuous running. They operate at 300 volts. In addition to the 7.5 kw. separate exciter there is a battery of 35 cells of 95 ampere-hour capacity which the exciter charges. The traction motors develop 360 hp. on the one hour rating and 160 hp. continuously.

The cruelest devastation in Belgium was not military, but was the deliberate destruction of industrial plants. German wrecking crews made incursions into the steel plants and used either dynamite or a destructive weapon they called the "sheep." With dynamite they disembowled furnaces and foundations. The "sheep" are heavy pieces of steel which were hoisted above machinery marked for destruction, and then allowed to fall from a height, with the result that in one instant these delicate and intricate machines were smashed into fragments. The damage at the big plant of Ougree-Marhaye, which before the war employed 9000 men, is estimated at $10,000,000. At Cockerill, a plant then employing 11,000 workers, the damage was $15,000,000.

The demand for telephones in Japan is so great that when one subscriber is ready to give up his telephone he sells it through a broker, there being a regular market value on the phone. At the end of 1917 there were 152,000 persons awaiting the installation of telephone instruments.

Personals

C. D. McClary, who has been connected with the Western Electric Co. in its various branch offices for several years, has been made sales manager of the Pittsburgh office.

Joseph J. Nelis, for the past year with Engineering Section, Emergency Fleet Corporation, Philadelphia, Penn., has accepted a position with the Power Specialty Co., 111 Broadway, New York, as marine representative for Foster boilers, superheaters and air heaters.

Engineering Affairs

The Indiana State Association, N. A. S. E., held its fifteenth annual convention at Terre Haute, June 26-28, at which the following officers were elected: President, A. Buldus, of Indianapolis; vice president, William Backle, of Evansville; secretary, A. N. Barnes, of Terre Haute; treasurer, E. G. Heeger of Evansville; conductor, John Vossler, of Richmond; doorkeeper and state deputy, Frank Clifford, of Kokomo.

The Cape May (N. J.) Association of the N. A. S. E., was instituted on the evening of July 7 by District Deputy John J. Reddy, assisted by W. J. Reynolds, Chairman of the National Board of Trustees. The following officers were duly installed: President, Benjamin Shertinlief; vice president, Walter Davis; recording and corresponding secretary, F. C. B. Speace; financial secretary, Harry Balm; treasurer, Coleman Camp; conductor, Rufus Cox; doorkeeper, Charles Swain; trustees, Albert Shertinlief, George Settle, G. F. Eldredge. This new association has started off favorably, and there is great hope for its success and expansion.

Business Items

The Central Station Steam Co., Detroit, Mich., has opened a branch office at 902 First National Bank Building, Chicago, with W. K. Abernethy, formerly manager of the Minneapolis office, in charge.

The C. & G. Cooper Co., Mt. Vernon, Ohio, has gotten out a richly illustrated 24-page booklet in colors, entitled "Our Bit." The book tells in brief the story of the company's part in the war. It is dedicated to its soldiers and workmen as a memorial to the men who went to war and those who stayed and worked to provide the machinery essential to warfare.

The Chicago Pneumatic Tool Co. announces the apointment of L. C. Sprague, formerly district manager of sales at New York, as manager of Western Railroad sales, with headquarters at Fisher Building, Chicago, and H. G. Barbee as manager of Eastern railroad sales, with headquarters at 52 Vanderbilt Ave., New York City. Nelson B. Gatch, formerly district manager of sales at Chicago, has been appointed district manager of sales at New York, succeeding Mr. Sprague. Announcement of Mr. Gatch's successor at Chicago will be made later.

The Merchants and Manufacturers' Exchange of New York has taken over Grand Central Palace for the purpose of turning it into a mammoth trade clearing house to be known as the International Material Handling Machinery and Factory Appliance Exchange. The Nemours Trading Corporation owns and controls the Merchants and Manufacturers' Exchange of New York, which has branches in all the leading cities and counties in the world. To this clearing house therefore will come inquiries from many parts of the world where machinery and other commodities are desired. Both large and small concerns whose products will stand examination and comparison may secure space in the various permanent expositions at a moderate price per annum. C. R. Ringenberg is secretary-manager of the Exchange, and prior to the opening may be reached at Suite 421, 405 Lexington Ave., New York City.

Trade Catalogs

The Carbo-Hydrogen Co. of America, Benedum-Trees Building, Pittsburgh, Penn., Catalogue, 6¼ x 9 in.; 27 pages, illustrated; describes the use of carbo-hydrogen apparatus for cutting steel and wrought iron.

The Peerless Superheater Co., Inc., New York City, has issued a bulletin of useful information on "Peerless All Steel Superheaters." Six plates showing line sections for the different types and makes of boilers are given. A copy of the bulletin may be had upon request.

The Combustion Engineering Corp., New York City, has issued Bulletin S-1 on the C. E. C. Tube Scraping Device, which describes a new and novel method of scraping the cinder and ash from the boiler tubes. The bulletin is nicely illustrated and will be sent to anyone free upon request.

Dayton-Dowd Co., Quincy, Ill., has issued its 15-page bulletin No. 240, showing its redesigned line of type CS single-stage, double-suction centrifugal pumps, with table giving the capacity, speed and efficiency of the different sizes. A page of useful engineering information is also given.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has recently issued the following bulletins: No. 1105 on "Stationary and Portable Air Compressor Equipments"; No. 1816 on "Crushing Rolls"; No. 1096-A on "Direct Current Motors and Generators." Copies of these bulletins may be had free upon request.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.15@2.75	$2.75@3.25
Philadelphia, gross tons	4.27@4.95	5.95@5.50
New York, gross tons	4.62@5.29	5.29@5.85
Alongside Boston (water coal), gross tons	6.10@6.85	6.90@7.55

Pocahontas and New River are quoted at $4.70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	5.10	6.85
Egg	6.15	8.00	Buckwheat	3.40	5.15
Stove	6.40	8.25	Rice	2.75	4.50
Chestnut	6.50	8.35	Barley	2.25	4.00

Bituminous

	Spot
South Forks	$2.95 @ $3.25
Cambria County (good grades)	2.75 @ 2.95
Clearfield County	2.50 @ 2.75
Reynoldsville	2.50 @ 2.75
Quemahoning	2.75 @ 2.95
Somerset County (best grades)	2.50 @ 2.75
Somerset County (poorer grades)	2.15 @ 2.35
Western Maryland	2.25 @ 2.50
Fairmont	1.90 @ 2.25
Latrobe	2.10 @ 2.25
Greensburg	2.35 @ 2.50
Westmoreland	2.60 @ 2.75
Westmoreland run-of-mine	2.35 @ 2.50

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.05	7.90	Rice	2.75	3.65
Stove	6.30	8.15	Boiler	2.50	3.50
Nut	6.40	8.25	Barley	2.25	3.15
Pea	5.00	6.60	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@2.50	3.00
Screenings	1.85@2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	.....
Williamson County		
Prepared sizes, lump, egg, nut	$2.55	$2.55	$2.00@2.25
Mine-run	2.35	2.20	1.60@1.75
Screenings	2.20	2.05	1.15@1.30
3-in. lump	....	2.30	.....
2-in. lump	....	....	1.75@1.90

Williamson-Franklin rate to St. Louis is $1.07; other rates 92½c.

New Construction

PROPOSED WORK

Me., Sanford—The Sanford Mills, c/o Lockwod-Greene Co., 101 Park Ave., New York City, will install a steam heating system in the 1 story dye house which they plan to build. Total estimated cost, $200,000.

Mass., Holyoke—Hall's Dairy, Inc., will install a steam heating system in the 2 story, 60 x 75 ft. building which it plans to construct on Sargeant St. Total estimated cost, $70,000. G. P. Alderman & Co., People Savings Bk. Bldg., Arch.

Mass., Worcester—The Walden-Worcester, Inc., 72 Commercial St., will install steam heating and power systems in the 4 story, 56 x 400 ft. factory which it plans to build on Shrewsbury St. Total estimated cost, $200,000.

Conn., New Britain—St. Mark's Episcopal Congregation, 21 Washington St., will install a steam heating plant in the 100 x 100 ft. church which it plans to build. Total estimated cost, $100,000. Carrere & Hastings, 52 Vanderbilt Ave., New York City, Arch.

Conn., New Haven—The Grace Hospital Association, 1418 Chapel St., received lowest bid for building a 5 story, 100 x 140 ft. hospital on Orchard St., from Dwight Bldg. Co., 24 Center St. A steam heating system will be installed. Total estimated cost, $300,000.

Conn., New London—W. T. Murphy, 143 Bank St., will install a vacuum heating system in the 3 story, 70 x 165 ft. theatre which it plans to build on Bank St. Total estimated cost, $125,000. H. R. Brewster, 295 East 17th St., Brooklyn, N. Y., Arch.

N. Y., Brooklyn—The Jewish Orphan Asylum, Dumont Ave., will install a steam heating plant in the 3 story, 65 x 95 ft. asylum which it plans to build on Dumont Ave. between Elton and Linwood St. Total estimated cost, $115,000. E. M. Adelsohn, 1778 Pitkin Ave., Engr.

N. Y., Brooklyn—The New York Telephone Co., 15 Dey St., New York City, will install a steam heating system in the 4 story, 60 x 125 ft. exchange which it plans to build at 14th Ave. and 41st St. Total estimated cost, $200,000. McKenzie, Voorhies & Gmelin., 1123 B'way., New York City, Engr.

N. Y., Brooklyn—The New Zion Hospital, 2140 Cropsey Ave., Bensonhurst, will install a steam heating system in the 4 story, 48 x 135 ft. hospital which it plans to build at 46th St. and 17th Ave. Total estimated cost, $250,000. Shampan & Shampan, 50 Court St., Arch.

N. Y., Central Islip—The State Hospital Commission, Capitol, Albany, received bids July 1 for installing coal and ash handling apparatus in the Central Islip State Hospital, here, from the Guarantee Construction Co., 140 Cedar St., New York City, $59,350; R. H. Beaumont, Drexel Bldg., Philadelphia, Penn., $68,825; Giffin-Wood Co., Hudson, $87,000; new boilers, stokers, etc., from the Austin Heating Co., 121 West 42nd St., New York City, $89,375 and W. B. Armstrong Co., 3 Fulton St., Albany, $94,942. Noted July 1.

N. Y., Hudson—The State Hospital Commission, Capitol, Albany, plans to replace underground steam and water mains and heating equipment in the training school here. Estimated cost, $15,000.

N. Y., Jamestown—The Art Metal Construction Co., Jones St. and G Ave., will install a steam heating system in the 4 story, 120 x 380 ft. factory, which it plans to build. Total estimated cost, $550,000. Lockwood-Greene Co., 101 Park Ave., New York City, Engr.

N. Y., Long Island City—The Patterson-Sargent Co., 8 Jay St., New York City, will install a steam heating system in the 4 story, 40 x 110 ft. addition which it plans to build to its factory on Van Dam St and Borden Ave., here. Total estimated cost, $200,000. Ballinger & Perrott, 47 West 34th St., New York City, Engr.

N. Y., Lowville—The Lowville Milk & Cream Co., operated by the Dairymen's League, will rebuild its plant recently destroyed by fire, entailing a loss of $15,000. An engine, boiler and an ammonia cooling system will be installed in same.

N. Y., New York—Buckley-Newhall Co., 125th St. and 5th Ave., will install a steam heating system in the 12 story, 100 x 125 ft. department store which it plans to build on 6th Ave. and 41st St. J. B. Snooks Sons, 261 Broadway, Engr.

N. Y., New York—The Cresent Realty Co., 26 East 23rd St., will install a steam heating plant in the 16 story, 150 x 290 ft. hotel which it plans to build on 5th Ave. and 50th St. Total estimated cost, $500,000. Warren & Clark, 108 East 29th St., Arch.

N. Y., New York—The Factory Construction Co., 44 Court St., Brooklyn, will install a steam heating plant in the 3 story, 95 x 175 ft. garage which it plans to build at 323 West 90th St. Total estimated cost, $100,000. F. S. Parker, 44 Court St., Brooklyn, Arch.

N. Y., New York—Lehn & Fink, 120 William St., will install a steam heating system in the 15 or 20 story office building which they plan to build on Greenwich and Morton Sts. Total estimated cost, $1,000,000. Buchman & Kahn, 56 West 45th St., Engr.

N. Y., New York—D. Neenan, 1966 B'way., will install a steam heating system in the 6 story, 90 x 100 ft. garage which it plans to build at 430-436 West 55th St. Total estimated cost, $200,000. J. C. Cocker, 2017 5th Ave., Arch.

N. Y., New York—The New York University, University Heights, will install a steam heating system in the 2 and 3 story addition which it plans to build. Total estimated cost, $500,000. Crow, Lewis & Wick, 200 5th Ave., Engr.

N. Y., New York—N. C. Partos, c/o L. A. Sheinart, Archt., 192 Bowery, will install a steam heating system in the 3 story, 75 x 197 ft. post office which he plans to build at 122 East 23rd St. Total estimated cost, $150,000. United States Government, Lessee.

N. Y., New York—The Webster Apartments, 280 Madison Ave., will install a steam heating system in the 13 story, 98 x 120 ft. hotel which they plan to build at 415 West 34th St. Total estimated cost, $528,000. Parish & Shroeder, 280 Madison Ave., Arch.

N. Y., New York—Wurlitzer & Co., 113 West 40th St., will install a steam heating plant in the 15 story, 50 x 85 ft. office and loft building which it plans to build at 119 West 41st St. Total estimated cost, $600,000. Maynicke & Franke, 25 East 26th St., Engr.

N. Y., Olden—The village bd. appointed W. B. Snyder, John Simme and others as a committee to obtain plans and estimates for water power developments and lighting system. Estimated cost, $100,000. Engineer not selected.

N. Y., Oneonta—Education Department, Education Bldg., Albany, received bids for the installation of boilers at the State Normal School, here, from C. H. Darmstadt, 352 West 43rd St., New York City, $16,000 and W. Devendorf, 470 Court St., Rochester, $16,990.

N. Y., Rochester—Rosenberg Bros. & Co. will install steam heating and ventilating systems in the 4 story, 55 x 299 ft. addition which they plan to build to their factory at Fashion Park. Estimated cost, $20,000.

N. Y., Salamanca—The Board of School Commissioners rejected bids for installing new heating and ventilating systems in the Maple St. School. Work will be re-advertised on contract at estimated cost, $16,000. Noted June 10.

N. Y., Saranac Lake—The Marr, Gordon Co., Inc., Au Sable Forks, is in the market for granite cutting machinery and electric motors.

N. Y., Westfield—The Board of Education plans taxpayers' election July 10 to vote on $15,000 bonds for installing a heating and ventilating system in District No. 1 school.

N. J., Camden—The Broadway Trust Co., 1009 Broadway, will install a steam heating plant in the bank which it plans to build at 1009 Broadway. Total estimated cost, $200,000. P. Merz, Pennsylvania Bldg., Philadelphia, Penn., Arch.

N. J., Camden—The Committee of Streets & Highways, Committee Room, City Hall, will soon award the contract for 2 boilers for an asphalt plant and 4 draught horses.

N. J., Hoboken—L. Newman & Co., Willow Ave., will install a steam heating plant in the 6 story, 50 x 65 x 140 ft. factory which it plans to build on Ferry St. and Willow Ave. Total estimated cost, $200,000. Starrett & Van Vleck, 18 West 40th St., New York City, Engr.

N. J., Newark—Max Spiegel, Strand Theatre Bldg., New York City, will install a steam heating system in the 1 story theatre which he plans to build on Broad St., here. Total estimated cost, $100,000. T. W. Lamb, 644 8th Ave., New York City, Arch.

N. J., Plainfield—The Board of Education will install a steam heating plant in the 2½ story, 55 x 150 ft. school which it plans to build on Emerson Ave. Total estimated cost, $140,000. Wilder & White, 50 Church St., New York City, Arch

N. J., Trenton—The City Commission plans to purchase several thousand dollars worth of new machinery for the city pumping station. J. Ridgeway Fell, 134 North Clinton Ave., Engr.

N. J., Woodbury—The First National Bank of Woodbury will install a steam heating plant in the 1 story, 35 x 106 ft. bank which it plans to build. Total estimated cost, $125,000. C. R. Peddle, 136 South 4th St., Philadelphia, Penn., Arch.

Penn., Coatesville—W. F. B. Boogar will soon award the contract for installing a steam heating plant in the 2 and 3 story, 150 x 200 ft. hotel, theatre and stores which he plans to build on 1st Ave. and Main St. Total estimated cost, $150,000. Stuckert Co., 1420 Chestnut St., Arch.

Penn., Harrisburg—The York Haven Water & Power Co., York Haven, will build a transmission line from Middletown to Anville. Estimated cost, $80,000. Work will be done by day labor

Penn., Philadelphia—The Vigogne Mills, Unity and Oakland St., will install boilers and engines, in connection with the 3 story, 65 x 250 ft. mill which they plan to build. M. Ward Erly, 1420 Chestnut St., Engr.

Md., Baltimore—The Board of Awards rejected only bid received for furnishing and erecting one 25 and one 15 kw. turbo-generator set and switchboard for the Mt. Royal Pumping Station; same being excessive. Work will be readvertised. W. E. Lee, City Hall, Water Engr.

N. C., Gastonia—The Main Street Methodist Congregation will install a steam heating plant in the 1 story, 175 x 200 ft. church which it plans to build on Main St. Total estimated cost, $150,000. C. C. Wilson, 804 Palmetto Bldg., Columbia, Arch.

N. C., Warsaw—The city will receive bids until July 31 for the construction of a waterworks system, to include boiler and pump. Total estimated cost, $125,000. W. M. Piatt, Durham, Engr.

N. C., Zebulon—Bids will be received until Aug. 5, by the city for the construction of a waterworks system, to include a pumping station. Total estimated cost, $150,000. W. P. Piatt, Durham, Engr.

S. C., Florence—The city will receive bids until July 29 for furnishing and installing motor-driven air compressers, motor-driven centrifugal pumps, airlift deep well apparatus and steel storage reservoir for improving waterworks. Total estimated cost, $10,000. G. C. White, Durham, N. C., Engr.

S. C., York—The City School Board will receive bids about Sept. 1 for the construction of a 2 story, 100 x 150 ft. high school. A steam heating and ventilating system will be installed. Total estimated cost, $110,000. C. C. Wilson, 804 Palmetto Bldg., Columbia, Arch.

Fla., Key West—The Bureau of Yards & Docks, Navy Department, Washington, D. C., rejected bids received June 25th for the construction of a power house, electric operating equipment and fire protection system here. Estimated cost, $105,000. Noted July 1.

Fla., Miami—J. J. Allison and C. G Fisher, 434 North Capitol Ave., Indianapolis, Ind., will install a steam heating plant in the 17 story, 90 x 557 ft. hotel which they plan to build. E. Powers, 318 Walnut St., Engr.

Tenn., Chattanooga—C. W. & G. L. Rapp, Arch., 190 North State St., Chicago, Ill., is receiving bids for the construction of a 1 story, 100 x 150 ft. theatre for the Signal Amusement Co., 719 Market St. A steam heating system will be installed. Total estimated cost, $250,000.

Tenn., Memphis—Loews Theatre Co., 1492 Broadway, New York City, will install a steam heating system in the 2 story, 100 x 100 ft. theatre which it plans to build on Union Ave., here. Total estimated cost, $300,000. T. W. Lamb, 644 8th Ave., New York City, Engr.

Ohio, Canton—The Board of Education will install a steam heating system in the 2 story, 114 x 200 ft. school which it plans to build on Vine and 16th St. Total estimated cost, $200,000.

Ohio, Cincinnati—Ascher Bros., 220 South State St., Chicago, Ill., will install a steam heating system in the 1 and 2 story, 100 x 135 ft. theatre and stores which they plan to build on 7th and Vine St. Total estimated cost, $250,000. H. L. Newhouse, 4630 Prairie Ave., Chicago, Ill., Arch.

Ohio, Cleveland—The Addison Square Investment Co., Addison Rd. and Wade Park Ave., will install a steam heating system in the 3 story, 100 x 200 ft. theatre which it plans to build. Total estimated cost, $100,000.

Ohio, Cleveland—The Arjo Realty Co., 214 Williamson Bldg., will install a steam heating system in the addition which it plans to build to its factory at 6545 Euclid Ave. Total estimated cost, $250,000. Lehman & Schmidt, 210 Electric Bldg., Arch.

Ohio, Cleveland—The Board of Education, East 6th St. and Rockwell Ave., will install a steam heating plant in connection with the 2 story, 100 x 100 ft. school which it plans to build on Eddy Rd. Total estimated cost, $250,000. H. R. McCormack, East 6th St. and Rockwell Ave., Engr.

Ohio, Cleveland—M. A. Bradley, Marion Bldg., will install a steam heating system in the 6 story, 150 x 200 ft. commercial building which it plans to build on Ontario and Fountain St. Total estimated cost, $100,000.

Ohio, Cleveland—The Euclid Prospect Corp., c/o Van Aken & Strock, 6525 Euclid Ave., will install a steam heating plant in the 12 story, 377 x 400 ft. apartment hotel which it plans to build at 2432 Euclid Ave. Total estimated cost, $4,000,000. Warren & Wetmore, 16 East 47th St., New York City, Engr.

Ohio, Cleveland—J. Glick, 10022 Euclid Ave., will install a steam heating plant in the 2 story, 80 x 270 ft. commercial building which he plans to build. Total estimated cost, $150,000.

Ohio, Cleveland—C. Graber, 15703 Detroit Ave., will install a steam heating plant in the 3 story, 67 x 94 ft. commercial building which he plans to build. Total estimated cost, $100,000.

Ohio, Cleveland—The Grace Hospital Association, 2307 West 14th St., will install a steam heating system in the addition which it plans to build to the hospital. Total estimated cost, $250,000.

Ohio, Cleveland—The Haddam Improvement Co., Hippodrome Bldg., will install a steam heating system in the 8 story, 150 x 239 ft. theatre which it plans to build on East 105th St. and Euclid Ave. Total estimated cost, $400,000.

Ohio, Cleveland—The Jones Gear Co., Guardian Bldg., will install a steam heating plant in the 2 story, 110 x 310 and 30 x 100 ft. factory and office which it plans to build on Wayside Rd. Total estimated cost, $130,000. G. A. Grieble, 517 Sloan Bldg., Engr.

Ohio, Cleveland—G. D. Koch & Son Co., 10300 Euclid Ave., will install a steam heating system in the commercial building which it plans to build at 10007 Euclid Ave. Total estimated cost, $100,000.

Ohio, Cleveland—The Ohio Athletic Association, 819 Guardian Bldg., will install a steam heating system in the 200 x 400 ft. club house and gymnasium which it plans to build. Total estimated cost, $500,000.

Ohio, Cleveland—The J. M. & L. A. Osborn Co., Superior Viaduct, will install a steam heating plant in the 2 story, 130 x 150 ft. warehouse which it plans to build on East 39th St. and Superior Ave. Total estimated cost, $300,000. G. S. Rider Co., 601 Century Bldg., Engr.

Ohio, Cleveland—K. V. Painter, Cuyahoga Bldg., will install a steam heating plant in the 10 story, 135 x 360 ft. commercial building which it plans to build on East 17th St. and Euclid Ave. Total estimated cost, $300,000.

Ohio, Cleveland—The Reserve Square Co., Schofield Bldg., will install a steam heating system in the 6 story, 100 x 300 ft. office building which it plans to build on East 11th St. and Chestnut Ave. Total estimated cost, $150,000. G. A. Grieble, 517 Sloan Bldg., Engr.

Ohio, Cleveland—The W. W. Sly Manufacturing Co., 4700 Train Ave., is in the market for an Ingersoll-Rand air compressor, type e.r. 1, St. L power, 12-in. cylinder, 10-in. stroke, 250 r.p.m., 244 cu.ft. of 80-in. air, and a 220 v. alternating current, 3 phase, 60 cycle motor of either 10-25 or 60 hp.

Ohio, Cleveland—The Temple Congregation, East 55th St. and Central Ave., will install a steam heating system in the 2 story, 100 x 200 ft. temple which it plans to build on West 107th St. and Wade Park. Total estimated cost, $500,000. Hubbell & Benes, 4500 Euclid Ave., Arch.

Ohio, Cleveland—The Wheeler Radiator Manufacturing Co., 1637 Collamer Rd., will install a steam heating system in the 4 story, 100 x 250 ft. addition which it plans to build to its factory. Total estimated cost, $250,000.

Ohio, East Cleveland—The city will install a steam heating system in the 6 story, 100 x 300 ft. hospital which it plans to build on Euclid and Prospect Ave. Total estimated cost, $250,000. Architect not selected.

Ohio, Euclid—The Board of Education will install a steam heating system in the 2 story, 75 x 100 ft. high school which it plans to build. Total estimated cost, $100,000. Knox & Elliot, 1248 Rockefeller Bldg., Arch.

Ohio, Hamilton—The city plans an election soon to vote on $600,000 bonds for the construction of a 5000 kw. lighting plant. F. E. Weaver, City Engr.

Ohio, Toledo—The Standard Oil Co., Cleveland, will install a waterworks system, to include a 15,000,000 gal. pumping plant, distribution and fire pressure system, in connection with the oil refineries, which it plans to build on the bay at Toledo. R. Winthrop Pratt, Hippodrome Bldg., Cleveland, Engr.

Ind., Hammond — Gumbiner Bros., c/o Rapp & Rapp, Archts., State-Lake Bldg., Chicago, Ill., will install a steam heating system in the 6 story, 150 x 210 ft. theatre and hotel which they plan to build on Homan and State St., here. Total estimated cost, $500,000.

Mich., Detroit—The Board of Education, 50 Broadway, received bids for installing steam heating and ventilating systems in the addition which it plans to build to Moore School on Alger and Cameron Ave., from J. W. Partlan, 51 Park Place, $56,661; R. L. Spitzley, 405 Vinton Bldg., $57,522; M. B. O'Connor, Penobscot Bldg., $61,391.

Mich., Detroit—The Board of Education, 50 Broadway, rebids for installing steam heating and ventilating systems in the addition which it plans to build to Dwyer School on Hawthorn and Caniff Ave., from J. W. Partlan, 51 Park Place, $55,295; R. L. Spitzley, 403 Vinton Bldg., $56,302; Ernst Bros., 35 Bagg St., $60,216.

Mich., Detroit—The Victor Theatre Co., 1140 Penobscot Bldg., will install a steam heating plant in the 2 story theatre, store, etc., which it plans to build on 52nd St. and Michigan Ave. Total estimated cost, $300,000. C. H. Crane and E. G. Kiehler, 2325 Dime Bank Bldg., Arch.

Mich., Highland Park (Detroit P. O.)—The Board of Education, Gerald Ave., will install a steam heating system in the 2 story, school addition which it plans to build on Waverly Ave. and Hamilton Blvd. Total estimated cost, $300,000. W. H. Adams, Vinton Bldg., Detroit, Engr.

Mich., Lansing—The city plans an election July 26 to vote on $350,000 bonds for building extensions to the electric-light plant.

Mich., Muskegon—The Continental Motors Corporation, Jefferson Ave., will build a 2 story, 180 x 500 ft. gasoline engine factory and power plant. Estimated cost, $1,900,000.

Mich., Saginaw—The Sonora Phonograph Co., 279 Broadway, New York City, will install a steam heating system in the factory which it plans to build. Total estimated cost, $1,000,000.

Mich., St. Claire—The Board of Education will install a steam heating system in the 2 story school which it plans to build. Total estimated cost, $150,000. Perkins, Fellows & Hamilton, 814 Tower Court, Chicago, Ill., Arch.

Mich., Wyandotte—The city will install a steam or hot water heating system in the 2 story, 150 x 350 ft. high school which it plans to build on Superior Ave. and 3rd St. Total estimated cost, $400,000. B. C. Wetzel & Co., 2317 Dime Bank Bldg., Detroit, Arch.

Mich., Wyandotte—B. C. Wetzel & Co., Arch., 2317 Dime Bank Bldg., is preparing plans for the construction of a 2 story, 135 x 140 ft. theatre and store building on Biddle and Maple Ave. A steam heating system will be installed. Total estimated cost, $200,000. Owner's name withheld.

Ill., Chicago—Balaban & Katz, c/o Central Park Theatre, 3535 West 12th St., will install a steam heating, refrigerating and ventilating plant in connection with the 125 x 175 ft. theatre which it plans to build on 63rd St. and Cottage Grove Ave. Total estimated cost, $1,000,000. Rapp & Rapp, 180 North State St., Arch.

Ill., Chicago—S. Birkenstein & Sons, Inc., 377 West Ontario St., will install a steam heating system in the 4 story, 100 x 330 ft. warehouse which they plan to build on Kingsbury St. near the Chicago River. Total estimated cost, $300,000. S. M. Eichburg, 64 West Randolph St., Arch.

Ill., Chicago—The Board of Education, 5 South Dearborn St., received bids in installing a steam heating system in the 3 story, 169 x 263 school which it plans to build on West 18th St. and South Keeler Ave., from F. W. Lamb Co., 24 East Kinzie St., $28,550; Hanley & Co., 5 North La Salle St., $29,235; National Steam Heating Co., 1331 North Clark St., $29,434. Noted June 17.

Ill., Chicago—The Bryn Mawr Hotel Co., c/o W. W. Ahlachlager, Arch., 111 West Washington St., will install a steam heating system in the 9 story 100 x 150 ft. apartment hotel which it plans to build on Bryn Mawr and Kenmore Ave. Total estimated cost, $1,250,000.

Ill., Chicago—The Chicago Beach Hotel Co., 51st St. and Cornell St., will install a steam heating system in the 12 story, 223 x 233 ft. hotel which it plans to build. Total estimated cost, $1,250,000. J. C. Hately, Pres. G. C. Nimmons & Co., 122 South Michigan Ave., Arch.

Ill., Chicago—The Chicago Butter & Egg Board, 136 West Lake St., will install a steam heating plant in the 10 story, 55 x 80 ft. office building which it plans to build on South Water and Wells St. Total estimated cost, $100,000. Lewis & Doherty, 35 North Dearborn St., Arch.

Ill., Chicago—The Chicago Dock & Canal Co., c/o C. A. Eckstrom, Arch., 5 North La Salle St., will install a steam heating system in the 6 story, 220 x 400 ft. warehouse which it plans to build on the North Pier. Total estimated cost, $500,000.

Ill., Chicago—The Commonwealth Edison Co., 120 West Adams St., will build two 2 story, 40 x 84 ft. concrete and brick transformer stations; one at 6909 Throop St. and one at 2644 Irving Park Blvd., each to contain 3 transformers of 4,000 k.w. capacity. Estimated cost, $175,000. Holabird & Roche, 104 South Michigan Ave., Arch.

Ill., Chicago—H. F. DuPoint, c/o Foltz & Brand, Arch., 111 West Washington St., will install a steam heating system in the 2 story, 110 x 150 ft. auto sales building which he plans to build on 22nd St. and Union Ave. Total estimated cost, $125,000.

Ill., Chicago—The Illinois Women's Athletic Club, 17 North State St., will install a steam heating plant in the 12 story, 125 x 220 ft. residential club which it plans to build on Rush and Pearson St. Total estimated cost, $1,000,000. Marshall & Fox, 721 North Michigan Blvd., Arch.

Ill., Chicago—R. Levine, 6957 South Halsted St., will install a steam heating plant in the 3 story, 175 x 175 ft. theatre, stores, etc., which he plans to build on Halsted and 70th St. Total estimated cost, $225,000. J. L. Koster, 6947 South Halsted St., Arch.

Ill., Chicago—The Pettibone-Mulliken Co., 725 Marquette Bldg., will install a steam heating system in the steel foundry which it plans to build. Total estimated cost, $200,000. Westinghouse, Church & Kerr, 37 Wall St., New York City, Engr.

Ill., Chicago—N. Thomasson, 4813 North Kedzie Ave., will install a steam heating system in the 3 story, 125 x 175 ft. theatre which he plans to build on Kedzie Ave. and Ainslie St. Total estimated cost, $375,000. Foltz & Brand, 111 West Washington St., Arch.

Ill., Chicago—The West End Hospital, 2058 West Monroe St., will install a steam heating plant in the 6 story, 36 x 150 ft. addition which it plans to build on Hoyers and Monroe St. Total estimated cost, $100,000. D. S. Klafter, 64 West Randolph St., Arch.

Ill., Joliet—L. F. Beach & Co. will install a steam heating system in the 4 story, 45 x 150 ft. department store which it plans to build on Cass St. and Chicago Ave. Total estimated cost, $150,000. D. H. Burnham & Co., 209 South La Salle St., Chicago, Arch.

Ill., Rockford—The Eclipse Stone Co. will install a steam heating system in the foundry which it plans to build. Total estimated cost, $200,000. Westinghouse, Church & Kerr, 37 Wall St., New York City, Engr.

Wis., Milwaukee—The Board of School Directors received lowest bid for installing a steam heating system in the school on Grand Ave. between 27th and 28th St., from the Downey Heating & Ventilating Co., 613 Clybourne St., Milwaukee.

Wis., Milwaukee—The Briggs-Stratton Co., Louis Ave., will install a steam heating and sprinkler system in the 5 story, 60 x 170 ft. addition which it plans to build to its factory on Milwaukee Ave. Total estimated cost, $500,000. H. J. Esser, Camp Bldg., Engr.

Wis., Milwaukee—Tharinger Bros. Macaroni Co., 1466 Holton St., will install a steam heating system in the 4 story, 120 x 130 ft. factory which they plan to build. Total estmiated cost, $125,000. C. H. Tharinger, c/o company, Arch.

Wis., Port Washington—The city will install one 600 h.p. Nordberg uniflow engine and a 500 kv.-a. generator in the 1 story, 20 x 40 ft. power house addition which it plans to build. Total estimated cost, $30,000. Douglas & Cahill, 301 Gross Bldg., Engr.

Wis., Sheboygan—The American Hide Co., c/o F. Schnellen, 1502 North 6th St., will soon award the contract for installing and furnishing all material for a steam ash chute system. E. Juul, 805 North 8th St., Engr.

Wis., Waukesha—The Board of Education has awarded the contract for installing a steam heating plant in the high school, to P. E. Mueller Co., 166 Reed St., Milwaukee. Estimated cost, $39,200

Wis., West Allis—The Board of Education plans to build a power house and install a steam heating plant in connection with the 2 story high school building which it plans to construct. Total estimated cost, $300,000. R. A. Messmer, Majestic Bldg., Arch.

Ia., Clinton—The Board of Education will install a steam heating plant in the 2 story high school which it plans to build. Total estimated cost, $300,000. Miller, Fullenwider & Dowling, 6 North Michigan Ave., Chicago, Ill., Arch.

Ia., Council Bluffs—The Council Bluffs School District plans to install a heating plant in connection with the 2 story, 100 x 325 ft. high school which it plans to build on Bway., between 25th and 26th St. Total estimated cost, $275,000. Proudfoot, Bird & Rawson, Hubbell Bldg., Des Moines, Engr.

Ia., Sac City—The Board of Education will install a steam heating plant in the 2 story, 85 x 150 ft. school which it plans to build. Total estimated cost, $100,000. Ashby, Ashby & Schulze, 178 West Jackson Blvd., Chicago, Ill., Arch.

Minn., Blooming Prairie—The School Board will install vacuum, steam heating and mechanical ventilating systems in the 2 story high school which it plans to build. Total estimated cost, $150,000. Jacobson & Jacobson, Owatonna, Engr.

Minn., Mankato—The city will soon award the contract for building 3 pumping stations in connection with improvements to the sewerage system. Total estimated cost, $20,000. F. W. Bates, City Clk.

Kan., Beloit—The Board of Education will install a steam heating plant in the 3 story, 100 x 137 ft. high school which it plans to build. Total estimated cost, $125,000. W. H. Saylor, Reliance Bldg., Kansas City, Arch.

Kan., Eldorado—The city will install a steam heating plant in the 2 story, 75 x 135 ft. memorial building which it plans to build. Total estimated cost, $100,000. G. P. Washburn & Son, Ottawa, Arch.

Kan., Eldorado—The School Board will install a steam heating plant in the 2 story, 100 x 170 ft. high school which it plans to build. Total estimated cost, $175,000. W. H. Simon, Arch.

Kan., Wellington—The city will soon award the contract for installing a steam heating system in the 2 story, 120 x 190 ft. auditorium which it plans to build. Total estimated cost, $125,000. C. Boller & Bro., 508 Ridge Bldg., Kansas City, Mo., Arch.

Kan., Wichita—The American Cemetery Co., c/o G. A. Saxton, Secy., 310 North Roosevelt Ave., will install a steam heating plant in the mausoleum which it plans to build on 21st St. and Hillside Ave. Total estimated cost, $100,000. S. Lovell, 30 North Michigan Ave., Chicago, Ill., Arch.

Neb., Superior—The School Board will install a steam heating plant in the school which it plans to build. Total estimated cost, $100,000. E. Davis, Lincoln, Arch.

S. D., Erwin—The Board of Education will install a steam heating plant in the 2 story, 65 x 134 ft. school which it plans to build. Total estimated cost, $100,000. K. T. Snyder, 933 Plymouth Bldg., Minneapolis, Minn., Engr.

Mont., Butte—The Butte Elk Park Extension Mining Co., 56 Owsley Blk., will install an electric driven hoist, capacity 200 tons per hour from 2000 ft., one 1200 cu. ft. air compressor, electric driven, 1 electric driven station pump, capacity 450 gal. per minute, and 1 electric transformer to take 110,000 volts, in the copper and silver mine at Elk Park. Total estimated cost, $65,000. C. C. Whitmore, Mgr.

Mo., Mt. Vernon—The Board of Managers will soon award the contract for installing a water system consisting of a 100,000 gal. steel tank, on a 75 ft. tower, furnishing and erecting a deep well pump, steam exhaust pump, discharge and supply lines, etc. T. C. Dusenbury, Secy. Hohenschild & Pearce, Odd Fellows Bldg., St. Louis, Engr.

Mo., Mexico—The directors of Hardin College plan to build a steam heating plant, dormitory, etc., on the campus. Total estimated cost, $260,000. J. W. Million, Pres.

Mo., Waco—The Allegheny-Western Mining Co. will move the old Adams mill from Tuckahoe and erect same at Waco, and is in the market for a steam engine and boilers. W. S. Marquis, Gen. Supt.

Tex., Wichita Falls—The committee of the Northwest Texas Insane Asylum will soon award the contract for the construction of an administration building at the asylum, here, including heating plant, etc. Total estimated cost, $350,000. C. H. Page & Bros., Austin National Bank Bldg., Austin, Arch.

Okla., Berry—The city plans to improve the waterworks and electric-light plant. Estimated cost, $100,000.

Okla., Tulsa—The trustees of the Henry Kendall College, Cleland and 7th St., are having revised plans prepared for the construction of a gymnasium. Plans include the installation of a heating plant. C. E. Buchner, Chn.

Nev., Winnemucca—The Supervisors of Humboldt County will install a steam heating plant in the 2 story court house which they plan to build. Total estimated cost, $120,000. F. J. De Longchamps, Nixon Bldg., Reno, Arch.

Ariz., Morenci—The Morenci School District will soon award the contract for installing a Plenum steam heating system in the high school which it plans to build. Total estimated cost, $150,000. G. Lewis Wilson, Monrovia, Cal., Arch.

Ariz., Sacatone—The State plans to construct an 11,000 volt transmission line from here to the State Penitentiary of Florence, total distance of 25 miles. Auxiliary equipment, such as transformers, etc., will be required. Estimated cost, $50,000. Thomas Maddock, Phoenix, State Engr.

Wash., Seattle—The Seattle Engineering School, 100 West Roy St., will install a gas engine department and boiler rooms in the 3 story, 165 x 240 ft. school which it plans to build on Queen Anne Hill. Total estimated cost, $135,000. S. D. Ford, Lyon Bldg., Arch.

Ore., Pilot Rock—The city plans to install a lighting plant, to have a capacity of 25 kw. Bonds for $4000 were issued to help defray the expenses of same. J. L. Vaughn, Mayor.

Ore., Salem—The State Board of Control will soon award the contract for installing a high pressure heating plant in the State Institution for Feeble Minded. F. A. Legg, Salem, Arch.

Ore., Salem—The Willard Service Battery Co., 6th and Burnside St., plans to construct a 2 story, 40 x 80 ft. battery plant on High St. Estimated cost, $10,000.

Cal., Brawley—The State Railroad Commission has ordered the Imperial Valley Gas Co., El Centro, to improve its service at Brawley. It will be necessary to add a steam boiler, blower, calorimeter and steel gas holder.

Cal., Long Beach—The Board of Education will install a heating and ventilating system, boilers, etc., in the 3-story school which it plans to build on American Ave. Total estimated cost, $200,000. Austin & Austin, 1021 Baker-Detwiler Bldg., Los Angeles, Arch.

Cal., Los Angeles—The Board of Public Service Commissioners will soon award the contract for installing transformers and other equipment for power plant No. 2, in the San Francisquito Canyon. Estimated cost, $600,000. L. M. Anderson, Auditor.

Cal., Los Angeles—The Board of Supervisors will install a steam heating system in the recreation building and cottages which it plans to build at the County Hospital on Mission Rd. Total estimated cost, $110,000. A. M. McPherrin, Clk.

Cal., Los Angeles—The Fowler Union High School District will install a Plenum heating system in the high school which it plans to build. Total estimated cost, $150,000. Allison & Allison, 1405 Hibernian Bldg., Arch.

Cal., Los Angeles—The University of Southern California, College of Liberal Arts Bldg., 35th and University St., will install a steam heating plant and Plenum ventilating system in the 3 story, 160 x 256 ft. administration building on University Ave. J. Parkinson, 420 Title Insurance Bldg., Arch.

Cal., San Francisco—Livingston & Co., c/o G. A. Lansburgh, Arch., Gunst Bldg., will install a steam heating system in the 6 story, 50 x 120 ft. loft building and stores which it plans to build on Geary St. and Union Sq. Total estimated cost, $150,000.

N. S., Wolfville—The Wright & Joudrey Co. will soon award the contract for the construction of a concrete power dam securing 28 ft. head, power house and 3 miles of transmission line, and is in the market for one 35 ft. turbine, generator, etc. Total estimated cost, $40,000. L. H. Wheaton, Halifax, Engr.

Ont., Bridgeburg—The city plans to build a pumping station and install new intake. Estimated cost, $15,000. J. D. Fitzgibbon, Bridgebury, Engr.

Ont., Kingston—The Municipal Council plans to expend $30,000 for new purifiers, $10,000 for liners and $10,000 for generators to be installed in the gas plant.

Ont., Port Colborne—The city plans to build a waterworks system and is in the market for materials and pumping equipment. Total estimated cost, $100,000.

Ont., Sarnia—The United Theatres, Ltd., will install a steam heating plant, boiler, etc., in the 2 story theatre which it plans to build on Victoria St. Total estimated cost, $75,000. J. Myers, Gen. Mgr.

Sask., Moosomin—The Town Council plans to install an electric-light plant. Estimated cost, $50,000.

CONTRACTS AWARDED

R. I., Waverley—The town has awarded the contract for installing pumping machinery for the proposed sewerage system, to the Power Equipment Co., 131 State St., Boston, Mass. Estimated cost, $6572.

Conn., Bridgeport—E. M. Jennings, 277 Fairfield Ave., has awarded the contract for the construction of a 5 story, 110 x 170 ft. garage and auto sales building on Harrison St., to the T. J. Pardy Construction Co., 15 Fairfield Ave. A vacuum heating system will be installed in same. Total estimated cost, $175,000.

Conn., Burnside—Case & Marshall, Inc., has awarded the contract for the construction of a 1 story power house to J. H. Grozier Co., 721 Main St., Hartford. Estimated cost, $25,000.

Conn., New Haven—The Yale Tire & Rubber Co., 827 Elm St., has awarded the contract for the construction of a 48 x 48 ft. power house on Dixwell Ave., to C. W. Murdock, 185 Church St. Estimated cost, $40,000. Noted May 27.

Conn., Putnam—The Nightingale-Morse Mills, Inc., have awarded the contract for the construction of a hydroelectric plant, to the H. Wales Lines Co., 134 State St., Meriden. Estimated cost, $30,000.

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a power distribution system at the Naval Air Station, here, to the Hamilton Electric Co., 357 3rd St., Brooklyn, $43,143. Noted July 8.

N. Y., Rockaway—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for extending the heating system, here, to E. Rutzler Co., 404 East 45th St., New York City, at $11,720. Noted July 8.

N. Y., Watertown—The H. H. Babcock Co. has awarded the contract for building a brick boiler house, 25 x 45 ft., 30 ft. high, on Farwell St., to Hodge & Foster, Watertown. Estimated cost, $12,000.

Penn., Philadelphia—The Niles-Bement-Pond Co., 21st and Callowhill St., has awarded the contract for the construction of a 1 story, 44 x 60 ft., brick power house on Swanson and McKean St., to the Standard Construction Co., 1713 Sansom St. Estimated cost, $10,000.

S. C., Charleston—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the installation of boilers and superheaters, here, to Heine Safety Boiler Co., 1120 Pennsylvania Bldg., Philadelphia, Pa., $41,750. Noted July 8.

Ohio, Cleveland—The Euclid Chester Co., Guardian Bldg., has awarded the contract for the construction of a 100 x 112 ft. warehouse at 2900 Chester Ave., to the Craig Curtiss Co., Guardian Bldg. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ill., Alton—The High School Board, Woodriver, has awarded the contract for installing a steam heating system in the 2 story, 90 x 150 ft. high school which it plans to build between Woodriver and East Alton, to Elliott & Barry Eng. Co., 1426 Olive St., St. Louis, Mo. Estimated cost, $25,000.

Ill., Chicago—The American Cities Hotel Co., 111 West Monroe St., has awarded the contract for the construction of an 8 story, 150 x 160 ft. hotel, on Stony Island Ave. and the Midway to M. Rauen, 111 West Washington St. A steam heating system and mechanical refrigerator and circulating ice water system will be installed. Total estimated cost, $400,000.

Ill., Chicago—Milton S. Plotke, 2519 North Clark St., has awarded the contract for the construction of a 2 story, 100 x 125 ft. store and office building on Sheridan Rd. and Montrose Blvd., to the Barrett Construction Co., 77 East Washington St. A steam heating plant will be installed in same. Total estimated cost, $100,000.

Ill., Rock Island—The Board of Education has awarded the contract for installing a steam heating system in the 3 story, 160 x 190 ft. school which it plans to build on 18th Ave. between 33rd and 34th St., to Ward & Mahon, Rock Island, at $20,820.

Mich., Detroit—Solomon Bros. have awarded the contract for the construction of a 6 story, 130 x 950 ft. terminal warehouse on Fort and Ferdinand St., to Walbridge-Aldinger Co., 2356 Penobscot Bldg. A vacuum steam heating system will be installed.

Kan., Beloit—The Board of Education has awarded the contract for installing a steam heating plant in the 3 story, 100 x 137 ft. high school, to Smith & Wells, 418 Convention Ave., Springfield, Mo.

Wash., Kelso—The North Coast Power Co., Winlock, has awarded the contract for the construction of a brick substation, capacity sufficient to cover three 20 k.w. transformers which are to be moved from Winlock to Kelso, to N. A. Strand. Estimated cost, $40,000.

Cal., Caribou—The Great Western Power Co., 14 Sansome St., San Francisco, has awarded the contract for the construction of a large power plant, to the Stone & Webster Co., 147 Milk St., Boston, Mass.

Que., Buckingham—The Electric Reduction Co. has awarded the contract for water power development, here, to the Foundation Co., Ltd., 224 St. James St., Montreal. Estimated cost, $30,000.

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